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North Birmingham Air Toxics Risk Assessment

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EXECUTIVE SUMMARY

This document reports on ambient air toxics monitoring and the resulting human health risk assessment in four North Birmingham, Alabama, communities. This study was designed as an extension of a previous effort, the national School Air Toxics (SAT) study, which focused on assessing outdoor air pollution near schools. The SAT results from data collected at two of the Birmingham schools suggested a need for additional monitoring in the four communities to better assess the long term potential risks of airborne contaminants in the neighborhoods. This monitoring and risk study is part of a larger initiative, the North Birmingham Pilot Community Air Toxics Initiative, which was designed in early 2011 by the US Environmental Protection Agency (EPA) and the Jefferson County Department of Health (JCDH), to address the overall air quality concerns in the four North Birmingham communities.

Monitoring stations were established at Hudson K-8 Elementary School in Collegeville, Lewis Elementary School in North Birmingham, Riggins School in Fairmont, and at the Shuttlesworth monitoring station in Harriman Park. Air samples were collected at the four sites from June 2011 to August 2012 and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and metals. Over 60 samples were collected at each location. The sampling and laboratory analysis process was subject to rigorous quality assurance/quality control procedures. Sampling results were evaluated and contaminants of potential concern (COPCs) were identified.

Both chronic (long-term) and acute (short term) inhalation exposures were estimated for individuals residing within the four communities. The chronic exposure assessment assumed an individual is exposed to the identified COPCs continuously for 24 hours per day over a 70-year period. The 95% Upper Confidence Level (95UCL) of the mean of the chemical concentration in air at a given monitor was used as the exposure concentration for an individual. The 95UCL is a value that, 95% of the time, equals or exceeds the true average concentration. The 95UCL is typically used as a conservative estimate of the true average concentration. Potential risk at each monitoring site was calculated by combining the 95UCL concentrations of each COPC identified in the analysis with toxicity data for the pollutants. For the chronic risk assessment, a distinction is made between potential risk of developing cancer and the potential for non-cancer health effects.

Results for the chronic cancer risk assessment indicate that each of the four of the monitoring sites has a total or "cumulative" risk of $1x10^{-4}$ (one potential additional cancer case in 10,000 exposed people). In general, the US EPA considers excess cancer risks that are below about 1 chance in 1,000,000 (1×10^{-6}) to be negligible and excess cancer risks that range from $1x10^{-6}$ and $1x10^{-4}$ are considered to be acceptable. Cancer risks calculated at each of the four monitoring sites fell within EPA's range of acceptability. In this study, the chemicals that contributed most to the total cancer risk are benzene and naphthalene.

Long-term non-cancer health hazards are evaluated in a two step process. First, a Hazard Quotient (HQ) is calculated by comparing the 95UCL concentrations to a reference dose considered to be a safe level of exposure. The HQs for COPCs are summed to determine the Hazard Index (HI) at a monitoring site. A HI of less than or equal to 1 is an indication that the cumulative impact of all of the COPCs at a given monitoring site is <u>not</u> likely to result in adverse, non-carcinogen health impacts. For monitoring sites where the HI exceeds 1, a second analysis is conducted to better assess the impact of COPCs on specific organs or systems (a Target Organ Specific Hazard Index, or TOSHI, analysis). The TOSHI is determined by summing each HQ for COPCs which affect the same target organ/system or have the same mechanism of action. A TOSHI value of less than or equal to 1 is an indication that the cumulative

impact of all of the COPCs to the same toxicological endpoint or mechanism of action at a given monitoring site is not likely to result in adverse, non-carcinogen health impacts.

In this study, the Hudson K-8 School, Lewis Elementary School, and Riggins School sites each had an initial HI of 2 and the Shuttlesworth site had an initial HI of 1. The Hudson K-8 School, Lewis Elementary School, and Riggins School results were further evaluated for impacts using the TOSHI approach. None of the resulting TOSHI values exceeded 1. All four of the monitoring sites in the study had the same chemicals as the largest contributors to non-cancer risk: Manganese, benzene, naphthalene, arsenic, 1,3-butadiene, and cadmium. Because no monitoring sites were found to have TOSHI values exceeding 1, it is unlikely that adverse non-cancer affects will occur.

Potential health effects from acute, or short-term, exposures were also evaluated. Acute exposures last a few minutes to several days. The acute exposure analysis consisted of comparing the maximum concentration of chemicals that were detected at least once to health-based comparison values. The individual sample results of this analysis indicated that benzene exceeded its acute comparison value in 3 out of 75 samples at the Riggins School site. This indicates that potential short-term health hazards resulting from elevated levels of benzene at this site at the time of sampling were possible on those days. The benchmark value for benzene was the ATSDR acute Minimum Risk Level (MRL), a concentration level considered protective of exposures lasting 24 hours to 14 days.

In general, the four monitors collected data that reflected similar outdoor air quality in each of the four monitored neighborhoods. The four sites appeared to be similar in the number and identity of COPCs, total cancer risks, non-cancer hazard indices and risk drivers. A summary table of the results is provided on the next page.

North Birmingham Air Toxics Study Summary of Results

Monitoring Site/ Community	Cancer Risk		Chronic Non-Cancer Hazard		Acute Hazard
	Total Risk	Risk Drivers and % Contribution to Total Risk	Hazard Index	Hazard Drivers and % Contribution to Hazard Index	
Hudson K-8 School/ Collegeville	$1x10^{-4}$	Benzene (47%), Naphthalene (19%), Arsenic (7%), 1,3-Butadiene(5%), Carbon Tetrachloride (4%), Benzo(a)pyrene (3%), p-Dichlorobenzene (3%), Cadmium (3%)	2	Manganese (44%), Benzene (13%), Naphthalene (12%), Cadmium (10%), Arsenic (7%), 1,3-Butadiene (5%)	None
Lewis Elementary School/North Birmingham	$1x10^{-4}$	Benzene (39%), Naphthalene (22%), Arsenic (8%), Benzo(a)pyrene (6%), 1,3-Butadiene (6%), Carbon Tetrachloride (4%), 1,2-Dichloroethane (3%), Ethylbenzene (3%)	2	Manganese (51%), Naphthalene (12%) Benzene (9%), Arsenic (7%), 1,3-Butadiene (5%) Cadmium (5%),	None
Riggins School/Fairmont	$1x10^{-4}$	Benzene (45%), Naphthalene (25%), Arsenic (8%), Benzo(a)pyrene (6%), 1,3-Butadiene (4%), Carbon Tetrachloride (3%), Dibenz(a,h)anthracene (2%)	2	Manganese (26%), Naphthalene (24%), Benzene (19%), Arsenic (12%), 1,3-Butadiene (7%) Cadmium (4%)	Benzene Exceedances: 3 out 75 samples)
Shuttlesworth Station/Harriman Park	$1x10^{-4}$	Benzene (37%), Naphthalene (26%), Arsenic (11%), 1,3-Butadiene (5%), Carbon Tetrachloride (4%), 1,2-Dichloroethane (4%), Benzo(a)pyrene (3%)	1	Manganese (36%), Naphthalene (19%), Arsenic (13%), Benzene (12%), 1,3-Butadiene (6%) Cadmium (5%),	None

1.0 INTRODUCTION

This risk assessment was conducted as a part of the North Birmingham Pilot Community Air Toxics Initiative (BPAT), which was designed in early 2011 by the US Environmental Protection Agency (EPA) and the Jefferson County Department of Health (JCDH), to address the overall air quality concerns in the four North Birmingham communities. Previous activities conducted as part of the BPAT include several outreach and educational workshops on sources of air toxics, permitting of industries, radon, mold, asthma management, and lead exposure.

The air toxics sampling data used in this risk assessment was collected from air monitors in each of the four North Birmingham communities. More than 60 samples were taken at each location for 24-hour periods from June 2011 through August 2012.

The purpose of this risk assessment is to provide information to decision-makers and other stakeholder on: 1) potential cancer risks and non-cancer hazards posed by chemicals present in ambient air as measured at the monitoring stations in four north Birmingham neighborhoods; and 2) the chemicals that pose the most risk to humans through inhalation at these four locations. This risk assessment does not address past or present health outcomes associated with current or previous exposures, potential risks through exposure pathways other than inhalation, or potential risks to ecosystems in the vicinity of the monitors.

This risk assessment was prepared in consideration of available EPA guidance documents, primarily the Air Toxics Risk Assessment Reference Library Volume 1 (USEPA, 2004). It should be noted, however, that EPA relies on a number of approaches and assumptions to evaluate environmental data to assess risks. For this analysis, we considered several approaches and assumptions to calculate risks and found them to result in similar estimates of risk. The approach and assumptions ultimately used in this assessment are described in the text of this document, and uncertainties associated with these decisions are discussed in Section 6.

1.1 Previous Air Studies

In late 2008, a series of articles in USA Today ranked the schools in the United States according to the risk from air toxics in the air around the schools. The ranking was based on a modeling approach developed by the newspaper's contractor. In response to the results of that report, the EPA developed a health risk screening study, the School Air Toxics (SAT) Initiative, to measure the levels of toxics in the air around schools throughout the nation to help understand whether the air quality posed potential health concerns (USEPA, 2009a). In March 2009, EPA selected the schools to be the focus of a targeted monitoring study using a number of factors, including results from an EPA computer modeling analysis, results from the newspaper series, and consultation with state and local air agencies. EPA and state and local air agency partners planned to use the results of this short-term screening study to determine next steps as they work to protect children's health where they live, play, and learn.

Three schools in the Birmingham, Alabama, area (Riggins, North Birmingham Elementary School, and Lewis Elementary School) were selected for the screening study primarily because they were located near industrial sources of air toxics emissions, including coke plants and a furnace steel mill. Data analyses suggested that the levels of a number of pollutants at the three schools, some of which are associated with

coke plant emissions (Benzene, arsenic, naphthalene, and benzo(a)pyrene), posed a potential for concern based on long-term continuous exposure, particularly in areas of the community close to the source of emissions. The study also found that manganese, while not found at levels of potential concern at the Lewis Elementary School, could be found at higher concentrations in other areas. Given that this analysis was a screening study and was based on limited short-term, EPA decided that a longer-term study was necessary. Conclusions regarding potential long-term effects of air toxics can only be drawn from a human health risk assessment that is based typically on a dataset from a minimum of one year of monitoring. The data collected in this screening study and associated reports are available at http://www.epa.gov/schoolair/.

In February 2009, the JCDH released the results of a risk assessment based on the Birmingham Air Toxics Study (JCDH, 2009). The effort consisted of an analysis of air toxics data collected over a one-year period from (2005-2006) at 4 locations in Birmingham. Samples were collected on a 12-day schedule for VOCs, SVOCs, and metals. One site, the Shuttlesworth Station, had levels above the long-term cancer risk acceptability range with benzene contributing most to the cumulative risk. Three sites were found to have non-cancer hazard indexes greater than 1.

1.2 Description of Study Area

The Birmingham Metropolitan Statistical Area consists of five counties including Jefferson, St. Clair, Walker, Blount, and Shelby. The City of Birmingham is centrally located in Jefferson County within the north central portion of the state (see Figure 1.2-1). Jefferson County is physically located in the foothills of the Appalachian Mountains, which creates a great diversity in topography, varying from fairly level to very steep while predominantly consisting of hilly terrain with the ridges oriented in a southwest-to-northeast direction. This topography has played a role in the development of the area as well as influencing land use. The city was once the primary industrial center of the southeastern United States.

Birmingham is the largest city in Alabama. It has an estimated population of 212,237 and a population density of 1,453 people per square mile (US Census Bureau, 2010). Age groups most often associated with sensitivity to chemical exposures (e.g., the young, the elderly, and physically/medically compromised individuals) are prevalent in the Birmingham area. For example, 7% of the population in the city of Birmingham is children under the age of 5 and approximately 22% of Birmingham's population is under 18. Almost 12% of the population is over 65. The population is predominantly African American (73%) compared to the entire state 26% African American. Whites represent 23%, and the remainder, American Indian and Alaska Native, Asians and mixed races, are 4% of the population. According to the US Census Bureau (2010), about one in four people (26%) in the city of Birmingham lived below the poverty level between 2006 and 2010 while the state estimate was only 17%. During the same time period, the median household income was $31,827, about 14% lower than the state's median estimate. Between 2000 and 2010, the city lost about 13% of its population while the state gained 8%.

Monthly average temperature, rainfall, and wind speed data for the air sampling period of this study was obtained from the Birmingham International Airport's weather station. This data is maintained by the National Climatic Data Center (NCDC, 2012) and is presented in Table1.2-1. The warmest month was August 2012 with an average monthly temperature of 83.4 degrees Fahrenheit (ºF). The lowest average monthly temperature of 38.8ºF occurred in January 2012. The monthly average rainfall varied from 0.48 inches in August 2011 to 12.1 inches in September 2011. The wind rose for the Birmingham area during the period of June 2011 to August 2012 is presented in Figure 1.2-2. A wind from the north implies that

airborne chemicals will predominantly move from north to south across the monitoring areas. The wind rose for the sampling period shows calm conditions about 36% of the time and winds from all directions the remainder of the time, with some peaks for winds out of the north, northwest, and southeast. (See Figure 1.2-2)

1.3 Organization of This Report

The remainder of this report is organized into the following main sections:

- Section 2, **Data Collection and Analysis**, presents details for the monitoring sites used in this assessment along with sampling and preliminary data analysis. Chemicals that were detected at least once are listed, and the Chemicals of Potential Concern (COPCs) are identified and listed for each monitoring site.

- Section 3, **Exposure Assessment**, determines exposure concentrations for each COPC. This section discusses both chronic (lifetime) and acute (hours to several days) exposures.

- Section 4, **Toxicity Assessment**, describes the hazard identification, dose-response assessment, and the potential health effects associated with the COPCs.

- Section 5, **Risk Characterization**, describes how cancer risks and chronic and acute non-cancer hazards are determined. It provides also a summary of the risk assessment results at each monitoring site.

- Section 6, **Uncertainty Analysis**, summarizes important sources of uncertainty in this assessment and the potential impacts on the risk and hazard estimates.

- Section 7 summarizes the conclusions of the risk assessment.

- References are provided in Section 8 followed by a Glossary of important acronyms and terms.

2.0 DATA COLLECTION AND ANALYSIS

This Section describes the monitoring process and summarizes the analytical data collected at the four monitors located in North Birmingham. Chemicals that were detected at least once at a given monitor and chemicals of potential concern (COPCs) were identified for detailed analysis. For the risk assessment, each monitor location is evaluated separately; as such, the data analysis and selection of the COPCs are presented individually for each monitor.

2.1 Site Selection and Monitoring

In June 2011, the EPA and JCDH started the North Birmingham Pilot Community Air Toxics Initiative (BPAT). The BPAT included a one-year air toxics monitoring and risk assessment study and several outreach and educational workshops on sources of air toxics, permitting of industries, radon, mold, asthma management, and lead exposure. The air monitoring portion of this initiative was designed to collect ambient air data that characterized the airborne concentrations of toxic air pollutants in four communities in the North Birmingham area.

The four communities selected for this air monitoring study were: Harriman Park, Collegeville, North Birmingham, and Fairmont. These communities were selected based on data from previous studies that suggested the possibility of ongoing air quality concerns. Monitoring stations were established at Hudson K-8 School in Collegeville, Lewis Elementary School in North Birmingham, Riggins School in Fairmont, and at the Shuttlesworth Monitoring Station in Harriman Park. Figure 2.1-1 provides approximate locations of the monitoring sites. Each of the sites was selected to represent a different scenario of land uses and potential types of sources of air pollution. A brief description of each site follows.

Hudson K-8 School Site

The Hudson K-8 School site is located on the roof of the school at 3300 Huntsville Road North, Birmingham, Alabama, 35207, in the Collegeville Neighborhood. This site is in the vicinity of a recovery metallurgical coke plant and a steel mill. The area around the site also includes residential homes, churches, and small businesses.

Lewis Elementary School Site

The Lewis Elementary School site is located on school's property off Finley Blvd. at 2015 26th Avenue North, Birmingham, Alabama, 35234. This site is near mobile sources (roadways), gasoline dispensing facilities, and a ductile iron pipe manufacturing facility. The area around the site consists of mixed commercial/industrial and residential. Lewis Elementary School was also a monitoring site during the short-term School Air Toxics Study.

Riggins School Site

The Riggins School site is located on school property in the Fairmont Neighborhood at 3177 44th Court North, Birmingham, Alabama, 35207. This site is near an asphalt batch plant and a recovery metallurgical coke plant. The area surrounding the site is primarily residential. This site was also a monitoring site during the short-term School Air Toxics Study.

Shuttlesworth Station Site

The Shuttlesworth site is located at 4113 Shuttlesworth Drive, Birmingham, Alabama, 35207. This site is near several large industrial sources, including a recovery metallurgical coke plant, asphalt batch plant and quarrying operations. This monitor is located alongside a road that serves as a major thoroughfare for both industrial and residential vehicular traffic. The area around the site is a residential/industrial mixture. The monitor at this site was also used to collect air toxics samples for the 2009 Birmingham Air Toxics study.

2.2 Monitoring Schedule and Analytical Parameters

Monitoring at the four sites was planned to be conducted over a one-year period, from June 2011 to June 2012. To account for potential seasonal variability, the monitoring consisted of collecting samples every sixth day, which would have resulted in approximately sixty sampling events at each location. However, the sampling was extended to August 2012 to replace samples that were void, missed or invalidated as a result of, for example, laboratory errors or malfunctioning equipment during the originally planned 1-year sampling period (See Section 2.3.1). From June to August 2012, samples were collected every third day at sites that had incomplete data sets after one year of sampling. In all cases, each composite sample was collected over a 24-hour period to account for potential temporal/diurnal variability. Samples were collected and handled according to the procedures presented in the Quality Assurance Project Plan (QAPP), which is available at http://www.epa.gov/ttn/amtic/files/ambient/airtox/2009sat/SATQAPP.pdf.

Three types of chemicals were collected at the four monitoring sites. They are defined by unique characteristics as shown below. Separate monitoring devices were used to evaluate air quality for each of these groups of chemicals.

Volatile Organic Compounds (VOCs)

VOCs are organic chemicals that have a high vapor pressure and tend to have low water solubility. They have a high propensity to evaporate and remain airborne. Many VOCs are human-made chemicals that are used in the manufacture of paints, pharmaceuticals, and refrigerants. VOCS are commonly used as industrial solvents, such as trichloroethylene , or are created as by-products, such as chloroform produced as a result of chlorination in water treatment. VOCs (e.g., benzene) are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents.

Semi-Volatile Organic Compounds (SVOCs)

SVOCs are organic chemicals that have a lower vapor pressure than VOCs and, thus, have a lower propensity to evaporate from the liquid or solid form. Once airborne, they also tend to condense out of the gas phase more readily. Examples of SVOCs include most organic pesticides (e.g., chlordane), and certain components of petroleum, such as polycyclic aromatic hydrocarbons. Note that the demarcation between SVOCs and VOCs is not exact. For example, the two separate air sampling and analytical methods for VOCs and SVOCs will both usually detect naphthalene when present, indicating that this chemical is on the lower end of the VOC scale of volatility and on the higher end of the SVOC scale of volatility. In general, as chemicals increase in molecular weight and/or polarity, they become more SVOC-like.

Metals

Metals are a group of elements with a set of distinct characteristics that can be found across much of the periodic chart. Metals can exist in particle form, including as a constituent of particulate matter (PM). Some metals exist in liquid or gaseous form. Metals can react with other chemicals to form a variety of metal-containing compounds.

A complete list of all chemicals sampled for at each of the four monitoring sites and analyzed in the laboratory for concentration levels is presented in Table 2.2-1. The list consists of a total of 91 chemicals, of which 58 are VOCs, 22 are SVOCs, and 11 are metals.

2.3 Data Quality and Validation Analysis

2.3.1 Air Monitoring Data and Analysis

The monitors at each site collected samples on the same schedule whenever possible. Rigorous data validation and quality assurance/quality control procedures were implemented for both sample collection and laboratory sample analysis. All samples were validated by checking monitoring parameters, including sampling flow rates. Samples were invalidated if: 1) The samplers did not run continuously over the 24-hour period; 2) When equipment malfunctions occurred; and/or 3) when the monitors did not maintain proper flows. Whenever samples were invalided, additional samples were collected on a three-day schedule beyond the originally planned 1-year sampling period in order to obtain at least 60 valid samples at each of the monitoring sites. Quality Assurance/Quality Control measures used in this study included collecting and analyzing duplicate samples and preparing and analyzing laboratory replicates, field blanks, and laboratory blanks.

Table 2.3.1-1 contains the sampling dates on which each valid samples was collected at each monitoring site. From June 24, 2011 to August 26, 2012, monitoring was reported for 75, 75, 75, and 72 sampling dates at the Hudson K-8 School, Lewis Elementary School, Riggins School, and Shuttlesworth Station sites, respectively.

2.3.2 Acrolein Sampling and Analysis Issues

Acrolein is a widespread pollutant that is an eye and respiratory irritant. The National Air Toxics Assessment (NATA) analysis of the 2005 inventory of air toxics emissions data indicates that acrolein is prevalent in many communities throughout the country, including Birmingham. Acrolein is a product of incomplete combustion and comes from fires, boats and planes, wood heating, industrial boilers and exhaust from cars and trucks. It is also found in cigarette smoke and smoke from cooking animal fats, and can form in the air when other chemicals break down. Children and adults with asthma and allergies may be more sensitive to Acrolein.

EPA, state and local air quality agencies are concerned about acrolein in the outdoor air and are working to reduce this pollutant across the country. However, results of a recent short-term laboratory study have raised significant questions about the consistency and reliability of acrolein monitoring results. It is one of the most difficult chemicals to measure in the air because it reacts easily with other chemicals to form

other compounds thus complicating laboratory analysis. This result is that, while we know that monitors are detecting acrolein in the air, we cannot determine precisely how much. In light of this uncertainty, EPA did not use acrolein monitoring data in evaluating the potential for health risks from exposure to air toxics in the School Air Toxics Monitoring Project. The Agency concluded that additional work is necessary to improve the accuracy of acrolein sample collection and analytical methods and is in the process of evaluating promising new technologies that may provide accurate data. To learn more about acrolein issues and the status of the project visit the SAT website: http://www.epa.gov/schoolair/pdfs/acroleinfsupdate.pdf.

The EPA decided not to perform analysis of acrolein data in this study because the data were collected and analyzed using the same problematic protocol as that associated with the SAT study. Additionally, concentration levels detected in this study were generally similar to what air quality monitors at other locations have measured in recent years. For example, similar levels were found in the SAT project at two locations in North Birmingham, the Birmingham air toxics study (JCDH, 2009), and the Loudon County, TN air toxics study (USEPA, 2009b). In all of these studies, the monitoring process and analytical methods were the same.

2.4 Air Sample Laboratory Analysis

All the samples were analyzed in the Eastern Research Group (ERG) laboratory in Morrisville, NC. Laboratory analyses were performed using EPA-approved methods, as follows:

- Compendium Method TO-15 for the analysis of VOCs air toxics. Samples were analyzed with the gas chromatograph/flame ionization detector/mass selective detector (GC/FID/MSD) using the Entech Instruments preconcentrator and 16-position autosamplers. The method is applicable to ambient air, indoor air, landfill gas, and any air samples where VOCs are not present at levels above hundreds of parts per billion by volume (ppbv). A copy of the document detailing this procedure is available at the EPA website at: http://www.epa.gov/ttnamti1/airtox.html

- Compendium Method TO-13A for the analysis of SVOCs. The method uses Selected Ion Monitoring procedures with gas chromatography. More information is available : http://www.epa.gov/ttnamti1/airtox.html

- Compendium Method IO-3.5. This method is for the sample preparation and analysis of suspended particulate matter. Metals are determined by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS). A copy of this procedure is available at: http://www.epa.gov/ttn/amtic/inorg.html.

All detection limits were reported as Method Detection Limits (MDLs) for each chemical contaminant and by each analytical method. The detection limits were determined by the ERG laboratory using 40 CFR, Part 136 Appendix B procedures (USEPA, 2005a) in accordance with the specifications presented in the National Air Toxics Trends Station (NATTS) Technical Assistance Document (USEPA, 2009c). By definition, MDLs represent the lowest concentration at which laboratory equipment can reliably quantify concentrations of specific pollutants at a specific confidence level. If a chemical concentration in ambient air did not exceed the method sensitivity (as gauged by the MDL), the analytical method might not differentiate the pollutant from other pollutants in the sample or from the random “noise” inherent in

laboratory analyses. While quantifications below the MDL were sometimes reported in the analytical results, the measurement reliability is lower. Therefore, all measurements under the respective MDL were considered non-detects in this study.

2.5 Data Screening and Preliminary Analysis

The purpose of selecting a subset of all detected chemicals is to narrow the focus of the risk assessment to just those chemicals detected during the monitoring study that are thought to have a significant contribution to inhalation risk at a given monitoring location. The basic steps used in the screening analysis and selection process to identify chemicals of interest were as follows:

1. Chemicals that were not detected at or above the detection limit in any of the samples at a monitoring site were eliminated and not carried through the risk assessment of monitoring data at that site.

2. Chemicals that were detected at or above the detection limit at least once but that did not have available dose-response values were retained for further analysis (See Section 4.0). At the end of this analysis, if a dose-response value was not available and could not be derived from ancillary sources, the chemical was excluded from the risk assessment.

3. Chemicals that were detected at least once at a monitoring site and for which dose-response values were available were retained and used in the acute hazard characterization analysis (see Section 5.2). The rational for retaining these chemicals for acute hazard characterization only, is that a chemical that is detected just once, or a few times, has the potential to result in an acute health hazard if present at relatively high concentrations.

4. Chemicals that were detected in 10% or more of the samples were selected as Chemicals of Potential Concern (COPCs). These COPCs were used in the chronic risk and hazard assessments. It is important to note that the selection of COPCs also eliminated from further consideration chemicals of low detection frequencies but with relatively high concentrations. Pollutants with this pattern of detection are not expected to result in significant exposure concentrations or chronic health impacts.

2.6 Chemical Screening Results

The results of the screening process are summarized in Tables 2.6-1 to 2.6-4 for all four monitors. These tables show chemicals that were detected at or above respective detection limits at least once, associated frequencies of detection and other descriptive statistics. Chemicals showing frequencies of detection of 10% or above were COPCs as indicated by an "X" in the last column of the tables. Fifty five chemicals out of a total of 91 were detected at least once in samples collected from the Hudson K-8 School site. Similarly, 44 chemicals for Lewis Elementary School, 46 chemicals for the Riggins School, and 45 chemicals for Shuttlesworth Station site were detected. The number of COPCs identified at these sites was 38, 38, 37, and 37 at the Hudson K-8 School, Lewis Elementary School, Riggins School, and Shuttlesworth Station sites, respectively (Table 2.6-5).

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Note that there is general agreement among the number and identity of COPCs identified at all four of these sites (See Table 2.6-5), indicating that air quality is relatively similar from site to site (but with

some important differences as discussed below). About a third of the 58 VOCs sampled and analyzed for, a third of the 22 SVOCs, and all 11 metals, except Antimony, were identified as COPCs at these sites.

A side by side comparison of monitoring sites in terms of maximum concentrations and frequency distributions shows some similarities but also some differences among the sites (Table 2.6-6). For example, all sites were identical with respect to COPCs, except for the chemical Trichloroethylene, which was a COPC at Hudson K-8 School and Lewis Elementary School sites, but not at Riggins School and Shuttlesworth Station sites. The detection frequencies were also similar across the sample locations.

3.0 EXPOSURE ASSESSMENT

Exposure assessment is the process that characterizes the route, duration, intensity, and frequency of contact with a chemical by a receptor. In this assessment, the potential receptors were individuals that may reside within the communities surrounding the monitoring sites, and the exposure route was inhalation. Two exposure durations were evaluated: chronic and acute.

3.1 Assessment of Chronic Exposures

Chronic exposures are usually relatively long in duration, but relatively low in concentration and may result in health effects that do not show up immediately and that persist over the long term, such as cardiovascular disease, respiratory disease, liver and kidney disease, reproductive effects, neurological damage, and cancer.

The 95th % Upper Confidence Limit (95UCL) of the long-term average concentration for each COPC at each monitoring site was estimated to represent a public health conservative estimate of chronic exposure to outdoor air at that location. The 95UCL is used in lieu of the arithmetic mean of the sampling results because the latter may underestimate the true annual average. The 95UCL is more likely to overestimate the true long-term average exposure and unlikely to underestimate the true chronic exposure. EPA's Superfund program has routinely used this procedure to evaluate exposures at hazardous waste sites, and this process has garnered long-term acceptance as a public health protective approach, in light of the uncertainties (e.g., using monitoring data collected every sixth day to represent air quality on unsampled days). EPA's air toxics program also uses this approach as indicated in its Air Toxics Risk Assessment guidance documents (USEPA, 2004). The following assumptions were used in the assessment of chronic exposure at the 95UCL:

- A person lives, works, and otherwise stays near a given monitoring location 24 hours per day for a 70-year lifetime.

- The air that the person breathes, both while indoors and outdoors, contains the same concentrations of pollutants measured in this North Birmingham study.

- Air quality, as reflected by the monitoring results, was assumed to remain constant over the entire 70-year lifetime of a person living in the area.

- A concentration equal to one half of the detection limit was assigned to non-detects for COPCs. Using one half of the detection limit, when no chemical was detected due to equipment limitations (or the chemical was detected below the detection limit), assumes that a chemical may be present in the environment, although at undetectable quantities. It should be noted that the USEPA recommends the Sample Quantitation Limits (SQLs), as opposed to the minimum detection limits, be used when they are available from the laboratory. EPA also suggests that MDLs may be used if SQLs cannot be obtained (see *Air Toxics Risk Assessment Reference Library. Vol. 1. Appendix H).* In this case, SQLs were not available.

- The arithmetic mean, median and standard deviation of the chemical data were calculated as follows:

The arithmetic mean was calculated as:

$$\bar{c} = \frac{\sum_{i=1}^{n} c_i}{n} \qquad \text{Equation 3-1}$$

where:

$\bar{c}$ = the arithmetic mean concentration;
c_i = an individual sample measurement; and
n = the total number of sample measurements.

The standard deviation was calculated as:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (c_i - \bar{c})^2}{n-1}} \qquad \text{Equation 3-2}$$

where:

s = the standard deviation of the concentration data;
$\bar{c}$ = the arithmetic mean concentration;
c_i = an individual sample measurement; and
n = the total number of sample measurements.

The median concentration was calculated for each chemical and monitor as the concentration value of the term in the middle of all the number of concentration data points if this number was odd. If the number of concentration data was even, then the median was the average concentration of the two terms in the middle.

The 95UCL value for normally distributed data is calculated using the following formula:

$$\bar{c}_{95} = c + \frac{s \bullet t_{95}}{\sqrt{n}} \qquad \text{Equation 3-2}$$

where:

$\bar{c}_{95}$ = 95^{th} percentile upper confidence limit on the mean;
$\bar{c}$ = the arithmetic mean concentration;
s = the standard deviation of the concentration data;
t_{95} = student's t statistic based on n-1 degree of freedom; and
n = the total number of sample measurements.

The 95UCL of the mean for each COPC was calculated based on the distribution of the chemical's sampling data using ProUCL version 4.1 (USEPA, 2010). For highly skewed concentration datasets, those that did not fit any known distribution such as normal, lognormal, and gamma, ProUCL used nonparametric tests such as Chebyshev *(mean Sd*) to derive the exposure concentrations.

The 95UCL calculated values for chronic exposure concentrations of all COPCs at all four monitoring sites are presented in Tables 3.1-1 to 3.1-4. These concentration values are the numbers used to represent

chronic exposure concentrations of COPCs and are expressed in micrograms-per-cubic-meter ($\mu g/m^3$). Other descriptive statistics were developed and are provided in the tables, including minimum, maximum, mean, and median concentrations, and the standard deviation. Note that the minimum chemical values in these tables may be surrogate values of ½ MDLs if the chemicals had at least one non-detect.

3.2 Assessment of Acute Exposures

Acute exposures are usually relatively short in duration (up to 24 hours), but relatively high in concentration and may result in immediate respiratory and sensory irritation, chemical burns, narcosis, eye damage, and various other effects (USEPA, 2004). Health effects that people may experience due to short–term exposures to airborne contaminants can vary significantly from those experienced after long-term exposure to low doses, depending on the contaminant and its concentration. For example, a substance that produces an increase in lung cancer risk after exposure to low concentrations continuously over a long period of time might also cause immediate and severe eye irritation if present at sufficiently high levels for a short period of time.

An acute exposure assessment is, however, more challenging than an assessment of chronic exposures. This is because available acute dose-response values are more diverse than chronic values; specifically, they were developed for a variety of purposes and frequently are based on different exposure durations. As a conservative approach for this risk assessment, the highest sampled concentration of each pollutant that was detected at least once at a monitoring site was compared to available acute exposure benchmark concentrations. Reliance on maximum measured concentrations to evaluate the potential for adverse effects from short-term exposures, as opposed to upper confidence limits of means, treats each sample independently, and thus avoids the potential to "average out" spikes in concentration. All chemicals that were detected at least once were used in the acute characterization rather than just the COPCs. This is because a chemical, although it may detected only once or a few times, may have elevated concentrations high enough to cause short-term effects.

4.0 TOXICITY ASSESSMENT (DOSE-RESPONSE ASSESSMENT)

The purpose of the toxicity assessment is to weigh available evidence regarding the potential for toxicity in exposed individuals (**hazard identification**) and to quantify the toxicity by deriving an appropriate dose-response value (**dose-response assessment**). Although the toxicity assessment is an integral and important part of the overall air toxics risk assessment, it is usually accomplished prior to the risk assessment. EPA has completed this toxicity assessment for many toxic air pollutants and has made available the resulting toxicity information and dose-response values for both chronic and acute exposures. One set of dose-response values has been developed for cancer-causing chemicals. A separate set of dose-response values has been developed for other non-cancer health effects (such as neurological damage). The assessment of risks posed by chronic exposure to chemicals typically evaluates the potential for chemicals to pose both cancer risks and non-cancer hazards. Assessment of acute exposures is usually limited to an assessment of non-cancer hazard (although cancer risks from short term, high-level exposures cannot be ruled out).

In general, these chronic and acute dose-response values were developed by the EPA and other government bodies. The chronic dose-response values used in this risk assessment were taken from EPA's *Dose-Response Assessment for Assessing Health Risks Associated with Exposure to Hazardous Air Pollutants* – Chronic Table 1, except for Lead (Pb). It is important to note that the value for lead in this table is not a dose-response value but its national ambient air quality standard (NAAQS). As a result, lead was analyzed as a criteria pollutant and not as a hazardous air pollutant (HAP) (See Section 5.1.5). The acute dose-response values used in this risk assessment were retrieved from Acute Table 2 of this same reference. Both tables can be found online at http://www.epa.gov/ttn/atw/toxsource/summary.html.

The toxicity values in Chronic Table 1 were themselves selected from available sources, based on the general hierarchy of data sources advocated by the USEPA's Office of Air Quality Planning and Standards (OAQPS). Wherever available, USEPA Inhalation Unit Risk estimates (IUR) for cancer and USEPA reference concentrations (RfCs) for non-cancer effects were used. When these values were not available, other toxicity values were used in the following hierarchical preference: (i) chronic minimal risk levels (MRLs) developed by ATSDR, (ii) California EPA inhalation unit risks and reference exposure levels (RELs), and (iii) USEPA's Health Effects Assessment Summary Table (HEAST) values. A description of each of these sources of information follows. Some chemicals lack inhalation assessments from these sources and, therefore, were not carried through the quantitative risk assessment. The potential consequences of having omitted these chemicals from the quantitative risk estimates are discussed in the uncertainty analysis. The toxicity values in Acute Table 2 were themselves selected from a set of available sources as described in Section 4.2 below.

- **U.S. Environmental Protection Agency (EPA)**. EPA has developed dose-response assessments for chronic exposure to many pollutants. These assessments typically specify an RfC (to protect against effects other than cancer) and/or IUR (to estimate the probability of contracting cancer). Background documents, particularly for the more recent files, also contain information on physical and chemical properties, toxicokinetics, and hazard characterization. EPA disseminates dose-response assessment information in several forms, based on the level of review. Dose-response assessments that have achieved full intra-agency consensus are incorporated in the **Integrated Risk Information System (IRIS)**, which is regularly updated and available on-line (www.epa.gov/iris). All IRIS assessments since 1996 also have undergone independent external

peer review. In the past, dose-response assessments for some substances were prepared by the EPA Office of Research and Development, but were never submitted for EPA consensus. EPA has assembled the results of many such assessments in the **Health Effects Assessment Summary Tables (HEAST)**. Although the values in HEAST have undergone some review and have the concurrence of individual Agency program offices, they have not had enough review to be recognized as Agency-wide consensus information. In addition, since HEAST has not been updated since 1997, other sources described here are, for many chemicals, more reliable.

- **Agency for Toxic Substances and Disease Registry (ATSDR)**. ATSDR, which is part of the US Department of Health and Human Services, develops and publishes Minimum Risk Levels (MRLs) for many toxic substances. The MRL is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (other than cancer) over a specified duration of exposure. MRLs are derived for acute (1-14 days), intermediate (>14-364 days), and chronic (365 days and longer) exposures by inhalation and oral routes. ATSDR describes MRLs as substance-specific estimates to be used by health assessors to select environmental contaminants for further evaluation. MRLs are considered to be levels below which contaminants are unlikely to pose a health threat. Exposures above an MRL do not necessarily represent a threat, and MRLs are therefore not intended for use as predictors of adverse health effects or for setting cleanup levels. The MRL data undergo a rigorous review process, including internal ATSDR review, peer reviews, and public comment periods. The ATSDR chronic MRL is used where no IRIS value is available, because the MRL's concept, definition, and derivation are philosophically consistent (though not identical) with EPA's guidelines for assessing noncancer effects. ATSDR publishes MRLs as part of pollutant-specific toxicological profile documents, and also in regularly-updated on-line tables.

- **California Environmental Protection Agency (CalEPA)**. The CalEPA Office of Environmental Health Hazard Assessment (OEHHA) has developed dose-response assessments for many substances, based both on carcinogenicity and health effects other than cancer. The process for developing these assessments is similar to that used by EPA to develop IRIS values and includes significant external scientific peer review. The non-cancer information includes inhalation health risk guidance values expressed as chronic inhalation reference exposure levels (RELs). CalEPA defines the REL as a concentration level at (or below) which no health effects are anticipated, a concept that is substantially similar to EPA's approach to non-cancer dose-response assessment. CalEPA's quantitative dose-response information on carcinogenicity by inhalation exposure is expressed in terms of the IUR, defined similarly to EPA's IUR. Specific CalEPA Unit Risk Estimates (UREs) are used where no IRIS values exist. CalEPA's dose response assessments for carcinogens and noncarcinogens are available on-line at http://www.oehha.org/air/hot_spots/index.html.

- **International Agency for Research on Cancer** (**IARC**). The IARC, a branch of the World Health Organization, coordinates and conducts research on the causes of human cancer and

develops scientific strategies for cancer control. The IARC sponsors both epidemiological and laboratory research, and disseminates scientific information through meetings, publications, courses and fellowships. As part of its mission, the IARC assembles evidence that substances cause cancer in humans and issues judgments on the strength of evidence. IARC's categories are Group 1 (carcinogenic in humans), Group 2A (probably carcinogenic), Group 2B (possibly carcinogenic), Group 3 (not classifiable), and Group 4 (probably not carcinogenic). The categorization scheme may be applied to either single chemicals or mixtures; however, IARC does not develop quantitative dose-response metrics such as UREs. IARC's categories for substances support or augment EPA's weight-of evidence (WOE) determinations, which do not cover all substances and in some cases may be out-of-date. The list of IARC evaluations to date is available on-line at http://www.IARC.fr.

The remainder of this section describes in more detail the hazard assessment process, the types of chronic and acute dose-response values that were used in this inhalation risk assessment, and additional information on the sources of these dose-response values.

4.1 Hazard Assessment for Chronic Effects

The hazard assessment, or hazard identification, process is usually part of an existing dose-response assessment for a chemical, and provides a summary of the available toxicity information for the air toxics being studied, and includes the weight of evidence determination and identification of critical effects. This step should answer the following questions:

- Can exposure to a chemical be linked causally to particular health effects?
- Could these effects occur at environmentally relevant concentrations?
- What is the nature and strength of the evidence of causation?

In the hazard identification step, evidence is gathered from a variety of sources regarding the potential for an air toxic to cause adverse health effects in humans for exposures occurring at relatively low levels over a long period of time (i.e., chronic exposure) and occurring at relatively high concentrations over relatively short exposure durations (i.e., acute exposure). These sources may include human data, experimental animal studies, and supporting information such as *in vitro* laboratory tests. The source and quality of data affects the overall uncertainties in the resulting human chronic dose-response values.

- **Human data**. Human toxicity data associated with exposures to air toxics may be generated from epidemiological studies, controlled exposure studies, or studies of accidental exposures. Well-conducted epidemiological studies that show a positive association between exposure to a chemical and adverse health effects often provide evidence about human health effects associated with chronic exposures. Such data, however, are available only for a limited number of air toxics. Epidemiological data also are very difficult to interpret, because the number of exposed individuals may be small, the incidence of effects may be low, doses are usually not well-characterized, and there may be complicating factors such as simultaneous exposure to multiple

chemicals and heterogeneity among the exposed group in terms of age, sex, diet, and other factors. Controlled exposure studies provide stronger evidence, since both the exposure duration and exposure concentrations are more accurately known. However, such studies with humans are generally limited to acute exposure durations. Studies reporting health effects associated with accidental exposures may be helpful, although exposure concentrations to air toxics may be high, and effects may be acute rather than chronic. In addition, a small sample size is often a significant limitation to interpreting controlled and accidental exposure studies.

- **Animal data**. The toxicity database for most air toxics is drawn from experiments conducted on non-human mammals such as rats, mice, rabbits, guinea pigs, hamsters, dogs, or monkeys. The underlying assumption is that the susceptibility of humans and these animals to the effects of the chemicals is broadly similar because we share many common biological attributes (e.g., similar organs, similar and, in some cases, identical metabolic processes). However, some observations in animals may be of uncertain relevance to humans (e.g., if tumors are observed in an animal experiment, but the organ in which the tumor is formed does not exist in humans). Also, it is necessary to adjust the results from animal studies to humans due to differences in body mass, anatomy, metabolic rate, and other species-specific factors (see, for example, Section 12.3.3). This is why derivation of dose-response values from animal studies requires considerable expertise.

- **Supporting data**. Metabolic, pharmacokinetic, and genotoxicity studies are sometimes used to infer the likelihood of adverse effects in humans. Metabolic studies on absorption, distribution, metabolism and elimination can provide information about the mechanisms of toxicity associated with a particular chemical in humans. In physiologically-based pharmacokinetic (PBPK) models the body is subdivided into a series of anatomical or physiological "compartments" that represent specific organs or lumped tissue and organ groups, and the behavior of the chemical is modeled in each compartment. Data on a chemical's pharmacokinetics, genotoxicity, and possible mode of action can be used to refine a toxicity assessment. In some cases, computer models using structure-activity relationships (i.e., predictions of toxicological activity based on analysis of chemical structure) also may be used as supporting evidence. EPA considers these types of data to be supportive, not definitive, evidence of a chemical's toxicity.

In hazard identification of carcinogens under the EPA guidelines, human data, animal data, and supporting evidence are combined to characterize the weight–of–evidence (WOE) regarding the agent's potential as a human carcinogen. Under this approach, the following categories have been established (USEPA, 1986):

Group A – Carcinogenic to Humans: Agents with adequate human data to demonstrate the causal association of the agent with human cancer (typically epidemiological data).

Group B – Probably Carcinogenic to Humans: Agents with sufficient evidence (i.e., indicative of a causal relationship) from animal bioassay data, but either limited (i.e., indicative of a

possible causal relationship, but not exclusive of alternative explanations) human evidence (Group B1), or with little or no human data (Group B2).

Group C – Possibly Carcinogenic to Humans: Agents with limited animal evidence and little or no human data.

Group D – Not Classifiable as to Human Carcinogenicity: Agents without adequate data either to suggest or refute the suggestion of human carcinogenicity.

Group E – Evidence of Non–carcinogenicity for Humans: Agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies.

Weight-of-evidence determinations for carcinogenicity developed by the International Agency for Research on Cancer (IARC) were used for carcinogens not characterized by USEPA. Carcinogens are categorized by IARC as Group 1 (agents carcinogenic to humans), Group 2A (probable human carcinogen), and Group 2B (possible human carcinogen).

The USEPA has revised the Guidelines for Carcinogenic Risk Assessment (USEPA, 2005b). Revisions to the Cancer Guidelines are intended to make greater use of the increasing scientific understanding of processes of cancer development. One area is the use of default options applied when critical information about the human health effects of a substance is lacking. For example, if no information is available regarding the human health effects of a substance, then a common default option is to assume that adverse health effects seen in animals from exposure to a substance have the potential to occur in humans as well. The revised Guidance provides greater detail on the EPA's policy for using the default options. The weight-of-evidence approach to characterizing the potential for a substance to be a human carcinogen has been retained, but a more complete narrative summary of the available evidence and the uncertainties and default assumptions used is recommended. The new guidelines also stress the importance of understanding the effects that a substance may cause in the body and how they might lead to the development of cancer. This information can be useful in determining the potency of a chemical as a carcinogen, the potential effects at low doses, who may be more susceptible to the substance, and whether animal studies are reliable indicators of potential effects in humans. The Guidelines have placed particular emphasis on the potential for increased vulnerability on childhood exposures. Although the new guidance is available, Regional risk assessments are not including the new narrative approach until such is applied in available Toxicity tables.

With regard to characterization of the available information on **non-cancer health effects** (or including cancer, if a threshold mode of action has been established), the targets of chemical toxicity within the body are identified, along with what have been termed "critical effects" associated with the toxicity. A **critical effect** is described as "either the adverse effect that first appears in the dose scale as dose is increased, or as a known precursor to the first adverse effect."

Underlying this designation is the assumption that if the critical effects are prevented, then all other adverse effects observed at higher exposure concentrations or doses are also prevented. Note that not all observed effects in toxicity studies are considered adverse effects. The identification of the critical effect(s) depends on a comprehensive review of the available data with careful consideration of the exposure conditions associated with each observed effect, so that comparisons of effect levels or potential reference values are made on a common basis. A more comprehensive discussion of hazard identification

and the evaluation of the underlying database for non-cancer effects is included in the EPA documents *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994) and *A Review of the Reference Dose and Reference Concentration Process* (USEPA, 2002).

4.1.1 Cancer Toxicity Values

A cancer toxicity value is a numerical value that, when matched with environmental exposure data, provides an estimate of the risk of developing cancer in the exposed population. For a carcinogen, the inhalation toxicity value is generally expressed as a risk per unit concentration of the chemical in air (e.g., risk per $\mu g/m^3$). This value is called an Inhalation Unit Risk (IUR) factor.

> **Inhalation Unit Risk (IUR)**: The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent via inhalation per $\mu g/m^3$ over a lifetime. The interpretation of the IUR would be as follows: if IUR = 2×10^{-6} per $\mu g/m^3$, not more than 2 excess tumors are expected to develop per 1,000,000 people if exposed continuously for a lifetime to 1µg of the chemical per cubic meter of inhaled air. The number of expected tumors is likely to be less; it may even be none.

Also note that only those substances that are known or suspected human carcinogens were considered in calculating cancer risks (USEPA WOE groups A, B, or C, or IARC classifications of 1, 2A or 2B). The toxicity information resulting from this assessment is presented later in Tables 5.1.1-1 to 5.1.1-4.

4.1.2 Chronic Non-cancer Values

For non–cancer effects, toxicity benchmarks are generally expressed as a concentration in air (e.g., an inhalation reference concentration or RfC in units of mg/m^3 air). The RfC is an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfC considers toxic effects for both the respiratory system (portal-of-entry) and for effects peripheral to the respiratory system (extra-respiratory effects).

Inhalation RfCs are derived according to *Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry* (USEPA, 1994). Because RfCs can also be derived for the noncarcinogenic health effects of substances that are carcinogens, it is essential to refer to other sources of information concerning the carcinogenicity of dual effect chemicals.

The toxicity information resulting from this assessment is presented later in Tables 5.1.2-1 to 5.1.2-4.

4.2 Hazard Assessment for Acute Effects

The set of acute benchmarks used in this assessment are from EPA's *Dose-Response Assessment for Assessing Health Risks Associated with Exposure to Hazardous Air Pollutants – Acute Table 2* which can be found online at http://www.epa.gov/ttn/atw/toxsource/summary.html. A description of the underlying sources is provided below:

AEGLs: National Advisory Committee for Acute Exposure Guideline Levels (NAC)
EPA's Office of Prevention, Pesticides and Toxic Substances established the NAC in 1995 to develop Acute Exposure Guideline Levels (AEGLs) and supplementary information on hazardous substances for federal, state, and local agencies and organizations in the private sector concerned with emergency planning, prevention, and response. The NAC is a discretionary Federal advisory committee that combines the efforts of stakeholders from the public and private sectors to promote efficiency and utilize sound science.

Since it began AEGL development with an initial priority list of 85 chemicals in May 1997, the NAC has produced AEGLs for 146 substances (available on EPA's website at http://www.epa.gov/oppt/aegl/). More information on procedures that are used to develop AEGLs is available (USEPA, 2001). The AEGLs for a substance take the form of a matrix, with separate levels for mild (AEGL-1), moderate (AEGL-2), and severe (AEGL-3) effects.

ERPGs: American Industrial Hygiene Association (AIHA)
AIHA has developed emergency response planning guidelines (ERPGs) for acute exposures at three different levels of severity (AIHA, 2001). These guidelines (available on-line through the US Department of Energy) represent concentrations for exposure of the general population for up to 1-hour. The expected effects of such exposures are categorized as mild or transient (ERPG-1), irreversible or serious (ERPG-2), and potentially life-threatening (ERPG-3).

MRLs: The U.S. Agency for Toxic Substances and Disease Registry (ATSDR)
ATSDR develops chronic, intermediate and acute minimal risk levels (MRLs) for some contaminants. An acute MRL is considered protective of exposures lasting from 24 hours to 14 days (ATSDR, 2002).

RELs: California Environmental Protection Agency (CalEPA)
CalEPA has developed acute dose-response assessments for many substances, expressing the results as acute inhalation reference exposure levels (RELs). As with its chronic RELs, CalEPA defines the acute REL (1-hr) as a concentration level at (or below) which no health effects are anticipated (CalEPA, 2002). CalEPA's acute RELs are available on-line at: http://www.oehha.ca.gov/air/acute_rels/index.html.

IDLH10: National Institute for Occupational Safety and Health (NIOSH)
As part of its mission to study and protect worker health, NIOSH determines concentrations of substances that are immediately dangerous to life or health (IDLH). IDLH values were originally determined for 387 substances in the mid-1970's as part of the Standards Completion Program (SCP), a joint project by NIOSH and the Occupational Safety and Health Administration (OSHA), for use in assigning respiratory protection equipment. NIOSH is currently evaluating the scientific adequacy of the criteria and procedures used during the SCP for establishing IDLHs. In the interim, the IDLHs have been reviewed and revised. NIOSH maintains an on-line database of IDLHs, including the basis and references for both the current and original IDLH values (as paraphrased from the SCP draft technical standards). Table 2 provides IDLH values divided by 10 to more closely match the mild-effect levels developed by other

sources, consistent with methodology used to develop levels of concern under Title III of the Superfund Amendments and Reauthorization Act, and their use in the accidental release prevention requirements under section 112(r) of the Clean Air Act.

TEELs: U.S. Department of Energy (DOE)
DOE has defined Temporary Emergency Exposure Limits (TEELs), which are temporary levels of concern (LOCs) derived according to a tiered, formula-like methodology (described at http://www.orau.gov/emi/scapa/Method_for_deriving_TEELs.pdf , and available on-line at http://www.atlintl.com/DOE/teels/teel/teel_pdf.html). DOE has developed TEELs with the intention of providing a reference when no other LOC is available. DOE describes TEELs as "approximations of potential values" and "subject to change." The EPA's emergency planning program (section 112(r)) does not generally rely on TEELs. They are provided in Table 2 purely to inform situations in which no other acute values are available. For example, a finding of an acute exposure near a TEEL value may indicate the need for a more in-depth investigation into the health effects literature. TEELs are not recommended as the basis of regulatory decision-making. Like ERPGs, TEELs are multiple-tiered one hour exposures, representing concentrations associated with no effects (TEEL-0), mild, transient effects (TEEL-1), irreversible or serious effects (TEEL-2), and potentially life-threatening effects (TEEL-3).

4.3 Total Chromium Toxicity Assessment

This study sampled and analyzed for total chromium, but not specifically hexavalent chromium (Cr^{+6}), the carcinogenic species of chromium, or trivalent chromium (Cr^{+3}), the noncarinogenic form. No toxicity values for total Cr are available to estimate its potential health risks. To evaluate the potential impact of chromium exposures, we estimated Cr^{+6} (which does have toxicity values) from tot Cr concentrations by multiplying total Cr by 1/100. The basis for this conversion is as follow:

1) The BATS study, which is referenced in this document, did analyze total Cr and Cr^{+6} in the North Birmingham study area and found that Cr^{+6} comprised about $1/100^{th}$ of the total amount of chromium present (the remainder is assumed to be Cr^{+3}).

2) In using the 1/100 ratio, we assumed that the conditions under which this study was conducted (e.g, sources, meteorology) are similar to those in the BATS study.

Toxicity values (IUR and RfC) for Cr^{+6} were used with estimated Cr^{+6} exposure concentrations to calculate health risks and hazards.

5.0 RISK CHARACTERIZATION

The risk characterization combines the exposure concentrations with the chronic and acute toxicity values to provide a quantitative estimate of the potential health impacts. Both chronic and acute exposures were evaluated. This section: 1) details how the risk characterization was conducted; 2) presents the results of the assessment; and 3) identifies the key risk drivers and provides a brief description of each. Risk and hazard results are reported in tables following standard rules for rounding and with one significant figure (USEPA, 2004). An assessment of uncertainties associated with the risk assessment is provided in Section 6.

5.1 Risk Characterization for Chronic Exposures

The risk characterization for chronic inhalation exposures was conducted by combining the relevant toxicity values with the exposure concentrations estimated from the monitoring data. The 95UCL exposure concentration was selected to represent a conservative estimate of exposure based on the 95UCL concentration of the COPCs in air.

5.1.1 Cancer Risk

In this assessment, risk estimates for COPCs with a cancer health endpoint were expressed in terms of the probability of developing cancer over a lifetime from continuous exposure to a constant ambient air concentration of the COPC. Cancer risk for each COPC at a monitoring location was derived as follows:

$$Risk_x = EC_x \times IUR_x \qquad \text{Equation 5-1}$$

Where:

$Risk_x$ = the risk of the X^{th} COPC at a monitor;
EC_x = the exposure concentration of the X^{th} COPC (95UCL air concentration); and
IUR_x = the inhalation unit risk of the X^{th} COPC.

The total cancer risk posed by all chemicals detected at a monitor is the sum of the individual COPC risks.

Estimates of cancer risk are usually expressed as a statistical probability represented in scientific notation as a negative exponent of 10. For example, an additional risk of developing cancer of one chance in 10,000 (or one additional person in 10,000) is written as $1x10^{-4}$ (or 1E-04). This means that for every 10,000 people that are exposed, ***in the way that we have presumed***, one of those people *may* develop cancer over their lifetime. Likewise, a risk of one person in one million is written $1x10^{-6}$ (or 1E-06) and a risk or one in one hundred thousand is written $1x10^{-5}$ (or 1E-05). Note that the calculated risks presented in this study are *in excess of* a person's chance of developing cancer for reasons *other than* the chemical exposures being evaluated (e.g., lifestyle risks such as smoking, genetic predisposition to certain cancers, etc.).

The Clean Air Act directed EPA to manage risks under Section 112 and according to the criteria specified in the 1989 National Emission Standard (NESHAP) for benzene (USEPA, 1999). In short, the benzene

NESHAP identified a cancer risk level of one in ten thousand ($1x10^{-4}$) as the approximate upper limit of acceptability and a cancer risk level of one in one million ($1x10^{-6}$) to be safe with an ample margin (USEPA, 1989).

Because IURs are typically upper-bound estimates, actual risks may be lower than predicted, and the true value of the risk is unknown and may be as low as zero. These statistical projections of hypothetical risk are intended as screening tools for risk managers and cannot make realistic predictions of biological effects. Such risk estimates also cannot be used to determine whether someone who already has cancer is ill because of a past exposure.

Risks for cancer are generally expressed as individual risks (i.e., the risk borne by an individual in a larger exposed population). In addition to assessing the risk to an individual in an exposed population, it is also possible to calculate the number of expected cases of cancer in that population over a 70-year period by multiplying the cancer risk to an individual by the number of individuals exposed; however, even though the calculation might yield a low predicted cancer incidence rate (even vanishingly small), that does not mean that individuals within the population will not get cancer because of air toxics exposures.

Risk Evaluation for Chemicals that are Carcinogens by a Mutagenic Mode of Action

For the COPCs benzo(a)pyrene, dibenz(a,h)anthracene, dichloromethane, and trichloroethylene, EPA has concluded that they are carcinogenic by a mutagenic mode of action and recommended that cancer risk assessments include additional assessment for ages younger than 16 years using age-specific default adjustment factors (ADAFs) with the slope factor provided in OAQPS Dose-Response values in Table 1 and age-specific exposure estimates as described in EPA's *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, 2005c). The ADAFs are 10 for exposures prior to 2 years of age (i.e., spanning 2-year interval from birth until second birthday), and 3 from ages 2 through 16 (i.e., spanning a 14-year interval from second until sixteenth birthday). For the compound trichloroethylene, we used the recently published IRIS-adjusted IUR of 4.8×10^{-6} per $\mu g/m^3$ (USEPA, 2011b). Assuming continuous exposure within the age group, the cancer risk for each of the remaining three compounds was estimated by:

1. Calculating the adjusted IUR, and
2. Multiplying the adjusted IUR by the exposure concentration

The calculations are as follows:

$$\text{Adjusted IUR} = (\text{IUR}*\text{ED}*\text{ADAF})/70 \qquad \text{Equation 5-2}$$

Where:

IUR = Individual unit risk in $1/\mu g/m^3$
ED = Exposure duration in number of years
ADAF = Age-dependent adjustment factor for a given age group

The overall adjusted IUR is calculated by summing all age group-adjusted IURs

$$\text{Cancer Risk for a compound} = \text{Adjusted IUR} * \text{EC} \qquad \text{Equation 5-3}$$

Where:

EC = Exposure concentration of the chemical, which in this case is the 95UCL concentration.

An example of calculations is provided below for benzo(a)pyrene at the Hudson K-8 School site:

Chemical Name	Age (Years)	IUR (1/ µg/m^3)	Exposure Duration (Years)	ADAF (Unitless)	Adjusted IUR (1/ µg/m^3)
Benzo(a)pyrene	0 - <2	$1.10x10^{-3}$	2	10	$3.14x10^{-4}$
	2 - <16	$1.10x10^{-3}$	14	3	$6.60x10^{-4}$
	16-70	$1.10x10^{-3}$	54	1	$8.49x10^{-4}$
	Total				$1.82x10^{-3}$

Cancer risk for benzo(a)pyrene at the Hudson K-8 School site =

$$0.0020\ \mu g/m^3 * 1.82\ x10^{-3}\ 1/\ \mu g/m^3 = 4x10^{-6}$$

5.1.2 Non-Cancer Hazards

In contrast to cancer risks, chronic non-cancer hazards are not expressed as a probability of an individual suffering an adverse effect. Instead, non-cancer hazard is expressed in terms of a *hazard quotient (HQ)*, defined as the ratio between the estimated exposure concentration and the Reference Concentration (RfC) or safe limit. For a given air toxic, exposures equals or below the RfC (HQ≤1) are not likely to be associated with adverse health effects, including for sensitive subpopulations. With exposures increasingly greater than the RfC, the potential for adverse effects increases. HQs were calculated as follows:

$$HQ_x = \frac{EC_x}{RfC_x} \qquad \text{Equation 5-4}$$

Where:

HQ_x = the hazard quotient of the Xth COPC at a monitor;
EC_x = the exposure concentration of the Xth COPC (95UCL air concentration); and
RfC_x = the reference concentration of the Xth COPC.

When multiple non-carcinogens were present simultaneously, as was the case at each of the individual monitoring stations in this study, the individual HQs are summed to create a hazard index (HI), thus:

$$HI = \sum (HQ1 + HQ2 + HQ3 + ...HQ_x) \qquad \text{Equation 5-5}$$

Where:

HI = the hazard index of all the COPCs detected at a monitor; and
HQ1 = the Hazard Quotients of individual COPCs 1 through x.

The HI is a measure of the potential for an adverse health effect from all of the COPCs combined. Different pollutants, however, may cause different adverse health effects or act via different mechanisms of action, so the initial step of adding all HQs together is only a screening step (USEPA, 2001). Based on the definition of RfC (see Section 4.2.1), a HQ or HI less than or equal to 1 indicates that adverse long-term noncancer effects are not likely to occur, and thus are considered to pose acceptably low hazard. However, when the initially calculated hazard index at a monitor exceeds a value of 1, a second step is typically required. Specifically, the aggregate hazards from COPCs that have the same toxic endpoint or act by a similar mechanism of action are added separately to give Target Organ Specific Hazard Indices (TOSHIs). For example, when the initial HI is greater than a value of one (1), the risk assessor may go back, for example, and separate those chemicals that just affect the respiratory system from chemicals that just affect the neurological system.

Procedure for Segregation of HIs by Effect

Segregation of HIs requires identification of the major effects of each chemical. Major effect categories include neurotoxicity, developmental toxicity, reproductive toxicity, immunotoxicity, and adverse effects by target organ (i.e., hepatic, renal, respiratory, cardiovascular, gastrointestinal, hematological, musculoskeletal, and dermal/ocular effects).

Unless otherwise noted, the hazard indices presented in this Section are the sum of all hazard quotients for all the COPCs detected at a monitor, which conservatively assumes that all of the COPCs have similarities in their mechanisms of action or all affect the same target organs. Where a TOSHI was developed, it has been noted.

In the following discussion of risk results, the total cancer risk and HI were presented for each monitor based on all COPCs selected for each monitoring site. For each site, the "risk drivers" (the chemicals that contribute to most of the estimated risk) were identified based on COPCs that are responsible for 90% of the risk. The use of risk drivers helps to focus the risk assessment (and subsequent risk management) on those COPCs with the greatest potential to impact human health. For chronic non-cancer hazard assessments, a HQ value of at least 0.1 was used to identify the hazard drivers or those COPCs that significantly contributed to a HI that exceeded a value of 1 at a monitoring site.

5.1.3 Cancer Risk Results

As discussed above, EPA typically considers an estimate cancer risk falling within the range of $1x10^{-6}$ and $1x10^{-4}$ to be acceptably low, with risks below $1x10^{-6}$ to be insignificant. The risks calculated in this study are discussed within the context of that risk range. The potential cancer risk estimates, along with percent contribution to the total risk, are presented for all COPCs at each of the four monitoring sites in

Tables 5.1.3-1 through 5.1.3-4. The tables also contain chronic inhalation carcinogenic toxicity values for the carcinogenic COPCs, the EPA and IARC WOE for each chemical, as well as the source of this information. Following is a summary of the chronic cancer risk results by monitoring site.

Hudson K-8 School site

The total cancer risk from all COPCs at the Hudson K-8 School site was $1x10^{-4}$. The risk drivers and percent contribution of each at this site were benzene (47%), naphthalene (19%), arsenic (7%), 1,3-butadiene (5%), carbon tetrachloride (4%), benzo(a)pyrene (3%), p-dichlorobenzene (3%), and cadmium (3%). The highest cancer risk was from benzene, which had a risk of $5x10^{-5}$, followed by naphthalene and arsenic ($2x10^{-5}$ and $8x10^{-6}$, respectively). These top three risk drivers accounted for 73% of the total risk. Their WOE are "carcinogenic to humans" for benzene and for arsenic, and "possible human carcinogen" for naphthalene. The remaining five risk drivers, which contributed 5% or less each to the total risk, had risk levels that varied from $3x10^{-6}$ to $5x10^{-6}$. Non-risk drivers that were at or above the $1x10^{-6}$ risk level at this site included 1,2-dichloroethane, ethylbenzene, hexavalent chromium, benzo(a)anthracene , and dibenz(a,h)anthracene.

Lewis Elementary School site

The Lewis Elementary School site had a total cancer risk of $1x10^{-4}$. The risk drivers were benzene (39%), naphthalene (22%), arsenic (8%), benzo(a)pyrene (6%), 1,3-Butadiene (6%), carbon tetrachloride (4%), 1,2-dichloroethane (3%), and ethylbenzene (3%). The highest cancer risk was from benzene, which had a risk of $4x10^{-5}$, followed by naphthalene and arsenic with risk levels of $2x10^{-5}$ and $8x10^{-6}$ respectively. These top three risk drivers accounted for 69% of the total risk. Each of the remaining five risk drivers, which contributed 6% or less each to the total risk, had risk values between from $3x10^{-6}$ to $6x10^{-6}$. Other COPCs (but not risk drivers) that had cancer risks above of or $1x10^{-6}$ at this location were p-dicholobenzene, cadmium, hexavalent chromium, dibenz(a,h)anthracen and benzo(a)anthracene.

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Riggins School site

The total cancer risk from all COPCs at the Riggins School site was $1x10^{-4}$. The risk drivers were benzene (45%), naphthalene (25%), arsenic (8%), benzo(a)pyrene (6%), 1,3-butadiene (4%), carbon tetrachloride (3%) and dibenz(a,h)anthracene (2%). The highest cancer risk was due to benzene, which had a risk value of $7x10^{-5}$, followed by naphthalene and arsenic with risk values of $4x10^{-5}$ and $1x10^{-5}$, respectively. These three risk drivers accounted for 77% of the total risk. Seven other COPCs had a cancer risk level at or above $1x10^{-6}$ at this site. They were 1,2-dichloroethane, p-dichlorobenzene, benzo(a)anthracene , hexavalent chromium, ethylbenzene, benzo(b)fluoranthene and cadmium.

Shuttlesworth Station site

The Shuttlesworth Station site had a total cancer risk of $1x10^{-4}$. The risk drivers were benzene (37%), naphthalene (26%), arsenic (11%), 1,3-butadiene (5%), carbon tetrachloride (4%), 1,2-dichloroethane (4%) and benzo(a)pyrene (3%). Benzene had the highest risk ($4x10^{-5}$) followed by naphthalene and arsenic ($3X10^{-5}$ and $1x10^{-5}$, respectively). These three risk drivers contributed 74% of the total risk. Each of the remaining four risk drivers accounted for 5% or less each of the total risk. Five other COPCs (p-dichlorobenzene, hexavalent chromium, ethylbenzene, cadmium and dibenz(a,h)anthracene) had risk values of or above $1x10^{-6}$.

5.1.4 Chronic Non-Cancer Hazard Results

Non-cancer health hazards with percent contributions to the HIs are provided for each monitoring site in Tables 5.1.4-1 through 5.1.4-4. The tables also contain the chronic non-carcinogenic toxicity values for the COPCs, the target organ potentially affected by the respective COPCs as well as the source of the information. As explained in Section 5.1.2, when a HI value is equal to or less than 1 or, where the HI exceeds 1 but the TOSHI value is equal to or less than 1, it is an indication that non-cancer effects are not likely to occur.

Hudson K-8 site

The 95UCL HI for the Hudson K-8 School site was 2. Chemicals at or above the 0.1 HQ-threshold were manganese (0.7), benzene (0.2), naphthalene (0.2), cadmium, (0.2), arsenic (0.1) and 1,3-Butadiene (0.1). At this site, no chemicals that affect the same organ/systems had a combined HQ (the TOSHI value) above 1.

Lewis Elementary School site

The 95UCL HI for the Lewis Elementary School site was 2. Manganese (0.9), naphthalene (0.2), benzene (0.2), arsenic (0.1), 1,3-butadiene (0.1), and cadmium (0.1) had HQs at or above the 0.1 HQ-threshold. No chemicals that affect the same organ/systems had a combined HQ (the TOSHI value) above 1.

Riggins School Site

The Riggins School site 95UCL HI was 2. Chemicals with HQ values above 0.1 at this site were manganese (0.4), naphthalene (0.4), benzene (0.3), arsenic (0.2), 1,3-Butadiene (0.1), and cadmium(0.1). No chemicals that affect the same organ/systems had a combined HQ (the TOSHI value) above 1.

Shuttlesworth Station site

At the Shuttlesworth Station site, the 95UCL HI was 1. Manganese (0.5), naphthalene (0.3), arsenic (0.2), benzene (0.2), 1,3-Butadiene (0.1), and cadmium (0.1) had HQs of 0.1 or above.

The results for non-cancer hazards analysis at each of the four monitoring sites indicate that non-cancer effects are not likely to occur.

5.1.5 Lead (Pb) Hazard Evaluation

Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Much of the lead found in the ambient air comes from human activities including metals industries, burning fossil fuels, mining, and manufacturing. Lead is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years.

Lead can affect human health in several ways, including effects on the nervous system, red blood cells and cardiovascular and immune systems. Infants and young children are especially sensitive to even low

levels of lead, which may contribute to learning problems and lowered IQ (see also http://www.atsdr.cdc.gov/ToxProfiles/tp13.pdf).

Lead can be found in the air, the soil, the water, and inside our homes. Much of the lead in the environment comes from past use of leaded gasoline in cars and trucks, some types of industrial facilities and past use of lead-based paint in homes. Lead and lead compounds have been used in a wide variety of products found in and around our homes, including paint, ceramics, pipes and plumbing materials, solders, gasoline, batteries, ammunition, and cosmetics. Babies and young children can be more highly exposed to lead because they often put their hands and other objects that can have lead from dust or soil on them, into their mouths. Children may also be exposed to lead by eating and drinking food or water containing lead or from dishes or glasses that contain lead. They may also breathe lead dust by spending time in areas where lead-based paint is deteriorating or from playing with toys with lead paint.

Concentrations of lead in outside air have greatly declined over the past few decades as a result of regulatory efforts to reduce lead emissions. To protect the public from harmful levels of lead in outside air, lead is regulated under the federal Clean Air Act by both the hazardous air pollutant (HAP) and criteria air pollutant (CAP) programs. CAPs are pollutants for which EPA establishes national ambient air quality standards (NAAQSs). There currently are no NAAQS for HAPs other than lead. In late 2008, EPA substantially strengthened this standard, revising it to be 10 times tighter than the previous standards, improving health protection for at-risk groups, especially children. The current NAAQS for lead is a "not-to-be-exceeded" 3-month rolling average concentration of 0.15 $\mu g/m^3$, in terms of lead in total suspended particles (Pb-TSP). A TSP sampler collects both small particles captured by PM_{10} samplers as well as larger particles and, thus, can capture a larger range of lead particles that might contribute to exposure. A significant lead exposure pathway for young children is hand-to-mouth contact with settled dust particles. The lead NAAQS is established in terms of lead in TSP in recognition of the potential contribution to this exposure pathway of particles not captured by PM_{10} samplers.

North Birmingham Risk Assessment Monitoring for lead: In this study, lead was measured, along with a suite of other toxic metals, in PM_{10} samples collected at the four neighborhood monitoring locations. The air samplers used do not meet the specific requirements for determining compliance with the lead NAAQS as this was not identified as an objective in the planning stage of the study. The results from these four locations provide important information about general air quality in these neighborhoods, but they are not definitive with respect to any of these neighborhoods' compliance with the lead NAAQS.

As a standard for public health protection has been established for lead, the lead NAAQS is considered the most relevant comparison value for evaluating the lead monitoring data. Accordingly, the rolling three-month lead concentrations measured at each of the four neighborhood monitoring sites was compared to the lead NAAQS level of 0.15 $\mu g/m^3$ as a way to screen the data for a potential lead issue in air in these neighborhoods. The results of this screening analysis indicated that the 3-month rolling average concentrations calculated at all four locations were below the lead NAAQS of 0.15 $\mu g/m^3$, although above 0.10 $\mu g/m^3$ three times at the Hudson K-8 School site (see table next page). The relatively high average concentrations at the Hudson K-8 School site were a result of two spikes in individual samples on 3/15/12 (1.13 $\mu g/m^3$) and 3/27/12 (0.53 $\mu g/m^3$).

Three-Month Rolling Lead Average Concentrations at the North Birmingham Air Monitoring Sites				
Three-Month Average as of Month/Year	Pb-PM_{10} Concentration ($\mu g/m^3$)			
	Hudson K-8 School	Lewis Elementary	Riggins School	Shuttlesworth Station
11-Aug	0.04	0.02	0.01	0.01
11-Sep	0.05	0.03	0.01	0.01
11-Oct	0.07	0.03	0.02	0.01
11-Nov	0.04	0.02	0.02	0.01
11-Dec	0.03	0.02	0.02	0.01
12-Jan	0.01	0.01	0.01	0.01
12-Feb	0.01	0.01	0.01	0.01
12-Mar	0.12	0.07	0.02	0.01
12-Apr	0.12	0.07	0.02	0.01
12-May	0.12	0.07	0.02	0.01
12-Jun	0.02	0.01	0.01	0.01
12-Jul	0.02	0.01	0.01	0.01

Other North Birmingham lead Monitoring: Lead monitoring is also conducted in the North Birmingham area at a multi-pollutant monitoring site (called an "NCore" site), located at 3009 28th Street in North Birmingham. This site, which is about a mile west of the Hudson K-8 School and just over a mile east of the Lewis Elementary school, has been collecting PM_{10} samples that are analyzed for lead since January 2012. The sampling method is different ("low volume PM_{10}") than that used at the neighborhood samplers ("high volume" PM_{10}) and samples are collected on a different schedule. Preliminary analysis of the available data collected at this site (January 2012 through September 2012), indicates 3-month rolling averages well below the lead standard as shown in the following table.

Three-Month Rolling Lead Average Concentration at the North Birmingham NCore Site							
3-Month Average as of Month/Year	3/12	4/12	5/12	6/12	7/12	8/12	9/12
Pb-PM_{10} Concentration ($\mu g/m^3$)	0.05	0.02	0.02	0.01	0.01	0.01	0.01

Conclusions: From this monitoring and meteorological evidence and from information about potential sources of lead in the area, the following conclusions are suggested:

1. Lead concentrations at the four neighborhood monitoring sites (3-month rolling averages) have been well below the NAAQS. One site (Hudson K-8), however, recorded three 3-month rolling

averages high enough to suggest that additional monitoring using TSP samplers may be needed. Monitoring with a TSP sampler at this location would enable a more complete evaluation of the potential for lead exposures of concern in the neighborhood around this site. But this comparison of results from the four neighborhood monitoring sites to the lead NAAQS has limitations because as indicated above, sampling at these sites used "high volume" PM_{10} samplers, as opposed to "low volume" PM_{10} samplers.

2. The three 3-month rolling averages at the Hudson K-8 School site that exceeded 0.10 µg/m^3 were the result of the high concentrations of lead in two samples (3/15/12 and 3/27/12). Otherwise the vast majority of 3-month averages at this site are significantly below the NAAQS. Elevated lead concentrations, although lower than at the Hudson K-8 School site, were also recorded at the other three neighborhood monitoring sites on 3/15/2012, indicating a common source.

3. Three-month average lead concentrations at the Ncore site were lower than those at the four neighborhood monitoring sites, but exhibited a generally similar pattern, seemingly reflecting the short March 2012 period of increased air lead concentrations.

4. Sources of airborne lead, such as current metals industries, exist in the North Birmingham area, although, none are estimated to individually emit lead at a rate above the trigger at which consideration of source-oriented monitoring is required by regulation. Small, unknown sources of airborne lead in the area, such as those associated with illegal metal smelting activities and industrial sites with historically contaminated surface soil/dust, are also possible.

5. The JCDH performed an investigation of the potential source(s) of the elevated lead concentrations measured on March 15 and 27, 2012, including discussions with local industries which may have had a startup, shutdown, or malfunction issue on those days. No apparent source of the high lead readings was identified. Likewise, meteorology on these days was also reviewed to determine if, for example, winds were blowing from a known potential lead source towards the monitors. No apparent meteorological connection to a source could be identified.

5.2 Acute Hazard Characterization

The acute toxicity characterization was based on a comparison of the maximum daily sample concentration for each chemical detected at least once at a given site to a range of acute benchmarks, when available (see Section 4.2 for the description of acute toxicity values). A chemical concentration higher than any of the benchmark values indicates that short-term health effects were possible on the day associated with that sampling event.

Table 5.2-1 compares the maximum concentration of each chemical that was detected at least once at a monitoring site to a series of acute dose-response values. Benzene was the only chemical for which the maximum concentration exceeded its respective acute benchmark and only at the Riggins School site. Benzene exceeded its acute benchmark value (ATSDR Acute MRL of 29 µg/m^3) on three different dates: 12/4/2011, 1/15/2012 and 4/2/2012. Corresponding concentration values for these exceedances were 38, 31, and 55 µg/m^3, respectively. No major variations in weather conditions were observed on the days of these occurrences that explain the high benzene concentration values. Also, based on a review of

operational records and other information obtained from industries in the area, no unusual events or malfunctions were noted on the days these samples were collected.

5.3 Description of Risk Drivers

Following is a brief description of potential risk drivers identified in this study, including sources and potential health effects. Additional information on each of the compounds can be obtained from the the EPA and ATSDR websites http://www.epa.gov/ttn/atw/hlthef/hapindex.html and http://www.atsdr.cdc.gov/toxfaqs/index.asp, respectively. They are presented in alphabetical order.

1,2-Dichloroethane

1,2-dichloroethane, also called ethylene dichloride, is a manufactured chemical that is not found naturally in the environment. It is a clear liquid and has a pleasant smell and sweet taste. The most common use of 1,2-dichloroethane is in the production of vinyl chloride which is used to make a variety of plastic and vinyl products including polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts. It is also used to as a solvent and is added to leaded gasoline to remove lead. Breathing high levels of 1,2-dichloroethane can cause damage to the nervous system, liver, kidneys, and lungs and may cause cancer.

1,3-Butadiene

Motor vehicle exhaust is a constant source of 1,3-butadiene. Its sources also include manufacturing and processing facilities, forest fires or other combustion, and cigarette smoke. High levels of 1,3-butadiene may be found in highly industrialized cities or near oil refineries, chemical manufacturing plants, and plastic and rubber factories. Although 1,3-butadiene breaks down quickly in the atmosphere, it is usually found in ambient air at low levels in urban and suburban areas. Acute (short-term) exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat, and lungs. Epidemiological studies have reported a possible association between 1,3-butadiene exposure and cardiovascular diseases. Epidemiological studies of workers in rubber plants have shown an association between 1,3-butadiene exposure and increased incidence of leukemia.

Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust. Arsenic, in its inorganic form, is found throughout the environment; it is released into the air by volcanoes, the weathering of arsenic-containing minerals and ores, and by commercial or industrial processes. Workers in metal smelters and nearby residents may be exposed to elevated inorganic arsenic released into the air. Other air sources of inorganic arsenic exposure include burning plywood treated with an arsenic wood preservative. Acute (short-term) high-level inhalation exposure to arsenic dust or fumes can cause gastrointestinal effects (nausea, diarrhea, abdominal pain) and nervous system disorders. Chronic (long-term) inhalation exposure to inorganic arsenic can cause irritation of the skin and mucous membranes and lung cancer.

Benzene

Benzene is a widely used chemical formed from both natural processes and human activities. It ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which

are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke. Benzene is found in airborne emissions from burning coal and oil, motor vehicle exhaust, and evaporation from gasoline service stations and in industrial solvents. These sources contribute to elevated levels of benzene in the ambient air, which may subsequently be breathed by the public. Tobacco smoke contains benzene and accounts for nearly half the national exposure to benzene. Breathing very high levels of benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia.

Benzo(a)pyrene

Benzo(a)pyrene is a polycyclic aromatic hydrocarbon (PAH). Polycyclic aromatic hydrocarbons (PAHs) are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat. PAHs are also found in coal tar, crude oil, creosote, and roofing tar, and a few are used in medicines or to make dyes, plastics, and pesticides. PAHs are usually found as a mixture containing two or more of these compounds, such as in soot. Benzo(a)pyrene (BAP) is the most well-studied of these compounds and long-term repeated exposure to BaP has been found to cause cancer.

Cadmium

The largest sources of airborne cadmium in the environment are the burning of fossil fuels such as coal or oil, and incineration of municipal waste materials. Cadmium may also be emitted into the air from zinc, lead, or copper smelters. For nonsmokers, food is generally the largest source of cadmium exposure. Cadmium levels in some foods can be increased by the application of phosphate fertilizers or sewage sludge to farm fields. Smoking is another important source of cadmium exposure.

Carbon Tetrachloride

Carbon tetrachloride was banned from consumer use in the United States in 1970. It is still used as a refrigerant and solvent, a primary source of exposure. Individuals may be exposed to carbon tetrachloride in the air from accidental releases from production and uses, and from its disposal in landfills where it may evaporate into the air or leach into groundwater. Carbon tetrachloride is also a common contaminant of indoor air; the sources of exposure appear to be building materials or products, such as cleaning agents, used in the home. Workers directly involved in the manufacture or use of carbon tetrachloride are most likely to have significant exposures to carbon tetrachloride. The primary targets of chronic and acute exposure are the liver and kidneys. It is also considered a probable carcinogen.

Hexavalent Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist as a liquid, solid, or gas. The most common forms are chromium (0), chromium (III), and chromium(VI) also known as hexavalent chromium. No taste or odor is associated with chromium compounds. Chromium (VI) eventually forms trivalent chromium ($Cr+^{3}$) after combining with dust particles and other pollutants in the atmosphere. The primary sources of hexavalent chromium in the atmosphere are chromate chemicals used as rust inhibitors in cooling towers and emitting as mists, particulate matter emitted during manufacture and use of metal chromates, and chromic acid mist from the plating industry. Hexavalent

chromium is a known human carcinogen. Exposure to chromium occurs from ingesting contaminated food or drinking water or breathing contaminated workplace air. Ingesting high levels of chromium (VI) may result in anemia or damage to the stomach or intestines.

Ethylbenzene

Ethylbenzene is a colorless, flammable liquid that smells like gasoline. It is found in natural products such as coal tar and petroleum and is also found in manufactured products such as inks, insecticides, and paints. Ethylbenzene is used primarily to make another chemical, styrene. Other uses include as a solvent, in fuels, and to make other chemicals. Breathing very high levels of Ethylbenzene can cause dizziness, and throat and eye irritation. Breathing lower levels has resulted in hearing effects and kidney damage in animals.

Manganese

Manganese occurs naturally. Manganese can be released into the air by iron and steel production plants, power plants, and coke ovens. In the still making process, Manganese is used as an additive to harden, stiffen and strengthen steel. Manganese is essential to human life, but only in small amounts. Exposure to excess levels of manganese can most commonly occur from breathing air in areas impacted by industrial sources of manganese. The most common health problems in workers exposed to high levels of manganese involve the nervous system. These health effects include behavioral changes and other nervous system effects, which include movements that, with high exposures, may become slow and clumsy.

Naphthalene

Naphthalene is a white solid that evaporates easily. Its sources include fossil fuels, such as petroleum and coal, tobacco, and wood burning. The major commercial use of naphthalene is to make other chemicals. It is used in such products as polyvinyl chloride (PVC) plastics, moth repellents, and toilet deodorant blocks. Other uses include making dyes, resins, leather tanning agents, and the insecticide carbaryl. About 10% of the naphthalene entering the environment is from coal production and distillation. Naphthalene has a strong but not unpleasant smell. Exposure to a large amount of naphthalene may damage or destroy some of the body red blood cells, a condition called hemolytic anemia. People, particularly children, have developed this problem after eating naphthalene-containing mothballs or deodorant blocks. Chronic exposure to naphthalene from these sources can cause respiratory inflammation and diseases of the eye, such as cataracts.

p-Dichlorobenzene

p-dichlorobenzene, also known as “para-dichlorobenzene” and “1,4-dichlorobenzene,” is considered a “possible human carcinogen” by USEPA. No information is available on human cancer effects of this chemical. The poor Weight of Evidence (WOE) for increased risk diminishes the significance of the risk/hazard values obtained, as no specific research has been done to link exposure to cancer in humans. It is commonly found as an indoor air pollutant in pest controls, deodorizers and disinfectants

6.0 UNCERTAINTY ASSESSMENT

The risk estimates used in air toxics risk assessments usually are not fully probabilistic estimates of risk but conditional estimates given a considerable number of assumptions about exposure and toxicity. Air toxics risk assessments make use of many different kinds of scientific concepts and data (e.g., exposure, toxicity, epidemiology), all of which are used to characterize the expected risk in a particular environmental context. Informed use of reliable scientific information from many different sources is a central feature of the risk assessment process. Reliable information may or may not be available for many aspects of a risk assessment. Scientific uncertainty is inherent in the risk assessment process, and risk managers almost always must make decisions using assessments that are not as definitive in all important areas as would be desirable.

Risk assessments also incorporate a variety of professional and science policy judgments (e.g., where to locate monitors and which toxicity studies to use as the basis of developing dose-response values). Risk managers therefore need to understand the strengths and the limitations of each assessment, and to communicate this information to all participants and the public. A critical part of the risk characterization process, therefore, is an evaluation of the assumptions and uncertainties inherent in the risk assessment in order to place the risk estimates in proper perspective. In most cases, the assessment of uncertainty is presented in a qualitative or semi-quantitative fashion, including a discussion of the likely direction and magnitude of the error associated with each important source of uncertainty. Some of the key areas of uncertainty in this risk analysis are presented below.

Monitor Location Selection: The risk and hazard estimates provided in this assessment were based on monitoring results from 4 monitoring sites in the North Birmingham communities. In each case, the assumption is made that the air quality data at the monitoring location is representative of exposures within some distance from the monitor (e.g., at the neighborhood level). However, it is not known how well each of these sites represent the potential receptors in immediate vicinity of the monitor (i.e., ambient air concentrations can vary at distance from the monitor); thus, exposure to individuals located at various distances from the monitoring site (and their actual risk) may also vary. If the monitoring sites were unrepresentative of any location beyond where they were sited, the monitoring data may over- or underestimate the true health impacts at the unmonitored locations.

Sampling Data Sufficiency: The risk and hazard assessment assumes that the sampling data are sufficient to draw conclusions regarding the populations that are localized near the monitor's placement. Furthermore, it is assumed that the sampling regime is sufficient to represent the exposures seen by the populations. The following are some of the potential shortcomings of the monitoring data:

- The monitoring data cover a little more than one year, but are used to represent a full lifetime (approximately 70 years) of exposure. This assumption, while pragmatic from a monitoring study point of view, is also problematic because of possibly of changing conditions over a long period of time. For example, environmental conditions and economic conditions can change over time (e.g., companies come and go and/or make different things), leading to a different exposure profile for people living in the vicinity of a monitor.

- Monitoring was staggered during the sampling study to capture samples on every day of the week and every season of the year (it was not sample to monitor continuously during the sampling

program). This approach, however, left some of the days unsampled over the course of the monitoring program.

- The monitors capture a combined 24-hr sample and so do not reflect spikes in concentrations throughout the course of a day.

- The monitors only evaluate a specific short list of potential chemical contaminants. Other chemicals may have been present, but not analyzed for.

- The monitors only look at outdoor air. No indoor air samples were taken where concentrations of certain toxics may be higher and where exposure times may be greater.

Making these assumptions may have resulted in over- or under-estimation of the potential risks.

Missed and Invalidated Samples and Void Data: The initial 1-year monitoring program was conducted at a schedule of 1 in 6 days. This schedule should have yielded 60 samples. However, some sites had had less than 60 valid samples. This is because some sampling events were missed or invalidated due to harsh weather conditions or equipment malfunctioning. Samples were also been voided in the laboratory if the conditions of analysis were not ideal. As a result, the monitoring program was extended for 2 more months and yielded at least 60 samples for each site. This resulted in an uneven number of samples and descrepancies in the dates of sampling. All of the replacement samples were taken in summer to replace missing samples, some of which were not taken in summer. This may have had the effect of either over- or underestimating the risk.

Data Utilized at ½ Method Detection Limit: Sampling data that were reported by the laboratory as "Not Detected" (ND) in a given sample were carried through the risk assessment using ½ the respective chemical's method detection limit as a surrogate for concentration. This reasonably conservative approach ensures that the chemical is considered to be present at least at some concentration (as opposed to not being present at all). Given the available MDLs, this approach is unlikely to significantly underestimate risk.

Sampling Data Reported as less than the Detection Limit: Analytical laboratories sometimes appear to measure trace level concentrations of chemicals at levels below the method detection limit when analyzing air samples. By definition, both the identity and concentration of such low level analytical results are suspect. For this risk assessment, we assumed "detections below the MDL" to be present at a concentration of ½ MDL since, on average, one could reasonably expect that outcome. This approach is not expected to have a significant impact on the overall conclusions of the assessment.

Exposure Duration: The risk estimates for exposure to the airborne concentration found at the four sites assume that an individual is continuously exposed at the same location for 70 years. Furthermore, it is assumed that the residents would be exposed 24-hrs per day, 7-days per week. The actual activity patterns of the residents are not considered but could lead to lower or higher exposures and resulting risks (for example, higher risks might occur for a person who lived in the area, but commuted to a job which involved relatively higher level exposures to toxic chemicals). Thus, this risk assessment may under- or overestimate the actual risks. Detailed information on the population in the North Birmingham area would be needed to reduce this uncertainty.

Exposure Concentration: It is assumed that the exposure concentration calculated using essentially 1 year of monitoring data does not change over a 70-year lifetime. Using the 95UCL as a conservative estimator of the true average helps reduce uncertainty in the annual estimated for the year monitored, but does not provide information about changing exposure patterns over the long term in which exposures may go up or down. As such, the computation of the exposure concentration for chemicals in air may have resulted in an overestimate or underestimate of risks. To reduce this uncertainty would require monitoring over several years, or modeling based on changes in estimated future meteorology and chemical emissions.

Toxicity Analysis - Chemicals without Dose-Response Values: Detected chemicals with no available dose-response values were not carried through the risk assessment process. This is likely to result in an underestimate of risk.

Toxicity Analysis - Route to Route Extrapolation: In limited circumstances, risk assessments may use route to route extrapolation (i.e., oral potency estimates extrapolated to inhalation potency) in an attempt to evaluate a chemical with no relevant toxicity information. Route to route extrapolation is recommended only from oral to inhaled exposure and only for carcinogens (USEPA, 2004). However, there were no instances where IUR values were missing while Oral Slope factors were available. Therefore, these approaches were not implemented.

Toxicity Assessment: The dose-response values used in this assessment were developed using a variety of assumptions and data, such as using information from laboratory animal studies and extrapolating from high-doses used in experiments to the low-doses actually expected in the environment. A variety of methods are used to ensure a margin of safety in the resulting dose-response values.

Total Chromium Toxicity: Total chromium does not have an established dose-response value but toxic hexavalent chromium, a potential component of total chromium, does. We estimated the hexavalent chromium concentrations from total chromium values based on the ratio of these two compounds previously determined in the North Birmingham area, and used that information to estimate the risk posed by total chromium. While the risks posed by hexavalent chromium are uncertain, it is noteworthy that results in this study are comparable to those found in the BATS study.

Acrolein Sampling and Analysis: During the School Air Toxics Monitoring Project (SAT), EPA raised questions about the consistency and reliability of air monitoring and analysis results for acrolein. The Agency decided not to analyze acrolein data as part of the SAT and has been working since that time on developing new technologies that may provide more accurate data. Likewise, we did not analyze acrolein data reported in this study. Excluding acrolein analysis means that hazard indices are likely to be underestimated. But, we do not know how high hazard quotients were and how much they would have contributed to hazard indices.

Lead (Pb) Hazard Evaluation: A comparison of this study's lead samples and the lead NAAQS is complicated by the samples not having been collected using TSP samplers. The samples are nevertheless relevant for screening potential exposures to airborne lead in the four North Birmingham neighborhoods. Several important uncertainties in this analysis include the following:

- The lead monitoring for this study used PM_{10} samplers which, in areas where airborne lead is present in larger particle sizes, may underestimate the airborne lead.

- One monitoring site (Hudson K-8 School) had three 3-month rolling concentration averages greater than 0.10 µg/m^3, a result which, if recorded using a low-volume PM_{10} sampler, would require siting of a TSP monitor.

An additional uncertainty is with regard to the potential for increased neurological hazard as a result simultaneous exposures to other neurotoxicants (e.g., manganese).

Acute Hazard Assessment: Many acute benchmark values used in this study were developed for 8-hour or shorter exposure time periods and then compared to 24-hour sample concentrations. Comparing 24-hour composite sample data to acute toxicity values with significantly lower exposure periods results in uncertainty as to whether some acute risks were undetected. This, coupled with having only sampled on a subset of days during the monitoring program means that the acute risks may be underestimated.

7.0 CONCLUSIONS

A risk assessment of the potential for adverse chronic and acute human health impacts from inhalation of air toxics has been conducted in four North Birmingham communities. Data were collected from four air monitoring sites in these communities from June 2011 to August 2012 and included 58 VOCs, 22 SVOCs, and 11metals. Acrolein was excluded from the risk analysis because present sampling and analysis methods are not reliable enough to accurately measure this chemical in ambient air. The EPA is working on developing more accurate methods. However, NATA analysis of the 2005 inventory of air toxics emissions data does indicate that acrolein is expected to be prevalent in many communities throughout the country, including Birmingham, as a product of incomplete combustion (e.g., from motor vehicles).

For each monitoring site, the COPCs were determined to be chemicals found in at least 10% of the samples. Data for the COPCs were then used in potential chronic risk and hazard assessments. All four sites had the same COPCs, except for trichloroethylene. This chemical was identified at Husdon K-8 and Lewis Elementary Schools as a COPC, but not at the Riggins School and Shuttlesworth Station sites. For acute hazard assessments, all chemicals that were detected at least once, rather than the COPCs, were evaluated.

In this risk assessment, the potential human health implications of the chronic exposures were characterized for both chronic cancer and non-cancer health effects using the 95UCL concentrations and chronic toxicity benchmark values. In addition, an acute risk characterization was performed. In this analysis, individual sample monitoring concentrations were compared to acute benchmarks.

The remainder of this Section provides the conclusions of the chronic and acute assessments, and end with a comparison with the BATS study.

7.1 Chronic Risk Characterization

In this risk assessment, each of the monitoring sites had a total cancer risk of $1x10^{-4}$. While the level of cancer risk that is of concern is a matter of personal and community judgment, the USEPA considers excess cancer risks below about 1 chance in 1,000,000 ($1x10^{-6}$) to be negligible, and excess cancer risks that range between $1x10^{-6}$ to approximately$1x10^{-4}$ to be generally acceptable. The three chemicals that pose the greatest portion of these risks are the same at all the sites and consist of benzene, naphthalene, and arsenic. Combined, they contributed 69 to 78% of the total risk at these sites. 1,3-butadiene and carbon tetrachloride are other risk drivers that were found at the four sites, although contributing 6% or less of the risk at each site. The remaining risk drivers, although contributing less to the cumulative risk, include benzo(a)pyrene, p-dichlorobenzene and cadmium at the Hudson K-8 School; 1,2-dichloroethane and ethylbenzene at the Lewis Elementary School; Benzo(a)pyrene and dibenz(a,h)anthracene at the Riggins School; and 1,2-dichloroethane and benzo(a)pyrene at the Shuttlesworth Station.

7.2 Chronic Hazard Characterization

The initial screening HI calculated for the Shuttlesworth Station is 1. The HI at the Hudson K-8 School, Lewis Elementary School, and Riggins School sites is 2. None of the individual risk drivers have an HQ

above 1. When additional toxicological information was taken into account (e.g., target organs), no HI was above 1, which indicates that adverse non-cancer effects are unlikely at each of the four sites. All the four sites have the same hazard drivers although in different concentrations. These COPCs were manganese, naphthalene, benzene, arsenic, 1,3-butadiene and cadmium.

7.3 Acute Hazard Characterization

The acute exposure analysis consisted of comparing the maximum concentrations of chemicals that were detected at least once at a monitoring site to acute benchmark values. The results indicate that benzene concentrations exceed the ATSDR acute MRL on 3 separate occasions at the Riggins School site. This indicates that potential short-term health hazards resulting from elevated levels of benzene at this site at the time of sampling were possible on those days. No major variations in weather conditions or unusual events or malfunctions at nearby industries were noted at on the days these samples were collected to explain the high levels of benzene.

7.4 Comparison with the 2009 Birmingham Air Toxics Study

The findings of this risk assessment are generally consistent with a prior risk assessment, the 2009 Birmingham Air Toxics Study, although cancer risk and non-cancer health hazard levels are lower in the present study. A comparison is made for only the results at the Shuttlesworth Station site because this monitoring site was used in both studies. Sampling protocols and analytical methods were nearly the same in both studies. The present study found a cumulative cancer risk of $1x10^{-4}$ at this site compared to $2x10^{-4}$ in the BATS study. Benzene, which contributed most to the total risk in both studies, decreased from 6 $x10^{-5}$ in BATS to 4 $x10^{-5}$ in this study. The risk levels associated with benzene, naphthalene, and arsenic were the top risk drivers in both studies. For non-cancer hazard effects, this study yielded an HI of 1 compared to 6 in the BATS study (excluding acrolein). The highest contributor to the HI (excluding acrolein) in both studies was manganese, but this COPC had an HQ of 4 in the BATS project compared to an HQ of 0.5 in the current study. Benzene exceeded the ATSDR acute MRL three times in this study but only once in the BATS project.

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9.0 GLOSSARY

AEGLs	Acute Exposure Guideline Levels
ATSDR	Agency for Toxic Substances and Disease Registry
BPAT	North Birmingham Pilot Community Air Toxics Initiative
BW	Body weight
CalEPA	California Environmental Protection Agency
CAP	Criteria Air Pollutant
CARD	Cardiovascular effects
CAS	Chemical Abstract Service
COPCs	Chemicals of potential concern
CPS_o	Oral cancer potency slope
DEV	Developmental effects
DL	Detection Limit
ERG	Eastern Research Group
ERPGs	Emergency Response Planning Guidelines
HAP	Hazardous Air Pollutant
HCl	Hydrochloric acid
HEAST	Health Effects Assessment Summary Table
HEM	Hematological effect
HEP	Hepatic effect
HI	Hazard Index
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
IR	Inhalation Rate
IRIS	Integrated Risk Information System
JCDH	Jefferson County Department of Health
IMM	Immunological effect
MRLs	Minimum Risk Levels
NAAQS	National Ambient Air Quality Standard
NATA	National Air Toxics Assessment
NATTS	National Air Toxics Trends Stations
NEUR	Neurological effect
Pb-PM_{10}	Lead measured as particulate matter less than 10 micrometers in diameter
Pb-TSP	Lead measured as total suspended particles
PCBs	Polychlorinated Biphenyls
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RELs	Reference Exposure Levels
RfC	Reference Concentration
RME	Reasonable Maximum Exposure
RPR	Reproductive effect
RSP	Respiratory effect
SAT	School Air Toxics
SKIN	Skin effect
SQL	Sample Quantitation Limit
SVOCs	Semi-Volatile Organic Compounds

TICs	Tentatively identified compounds
TOSHI	Target Organ Specific Hazard Indices
TSP	Total Suspended Particles
UCL	Upper Confidence Limit
URE	Unit Risk Estimate
VOCs	Volatile Organic Compounds
WOE	Weight of Evidence

Figures

Figure 1.2-1 Travel Map of the Birmingham, AL Area

Figure 1.2-2. Wind Rose in the Birmingham Area, from June 2011 to August 2012

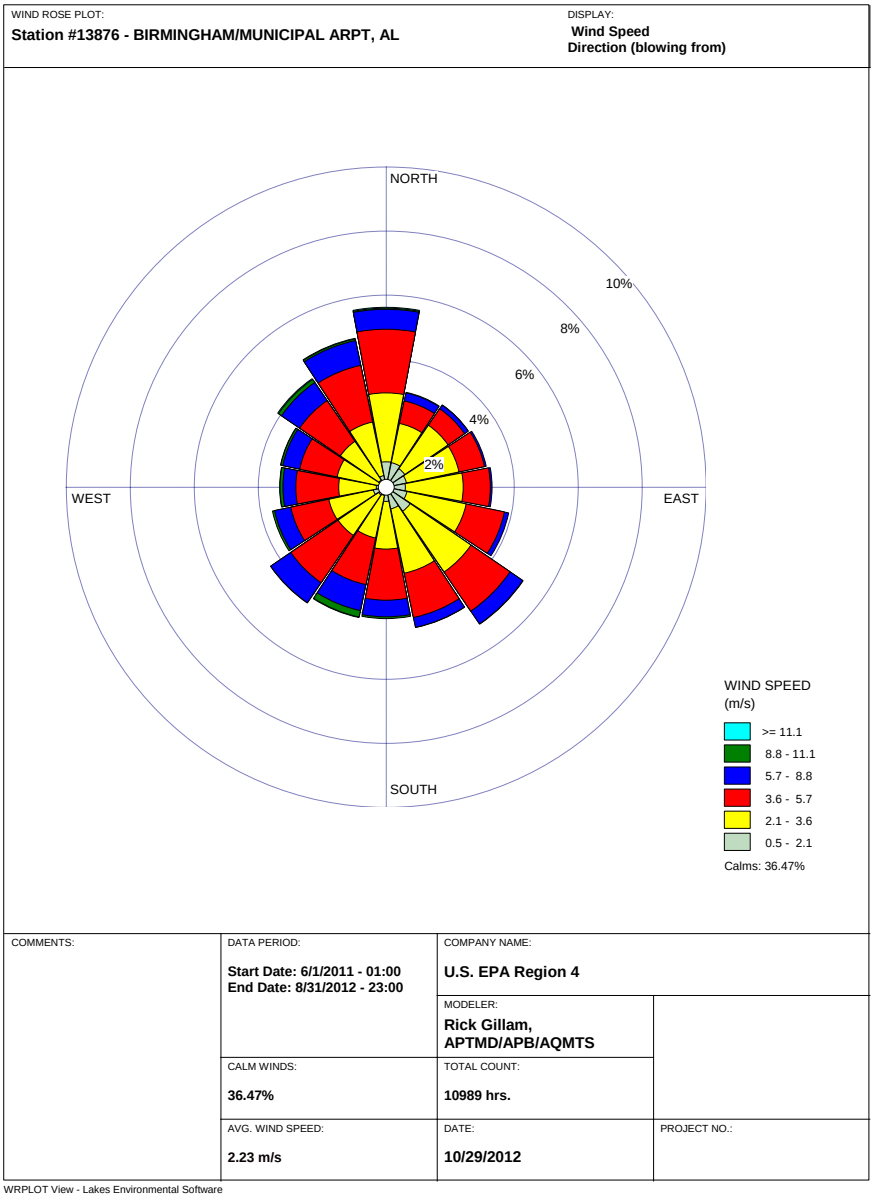
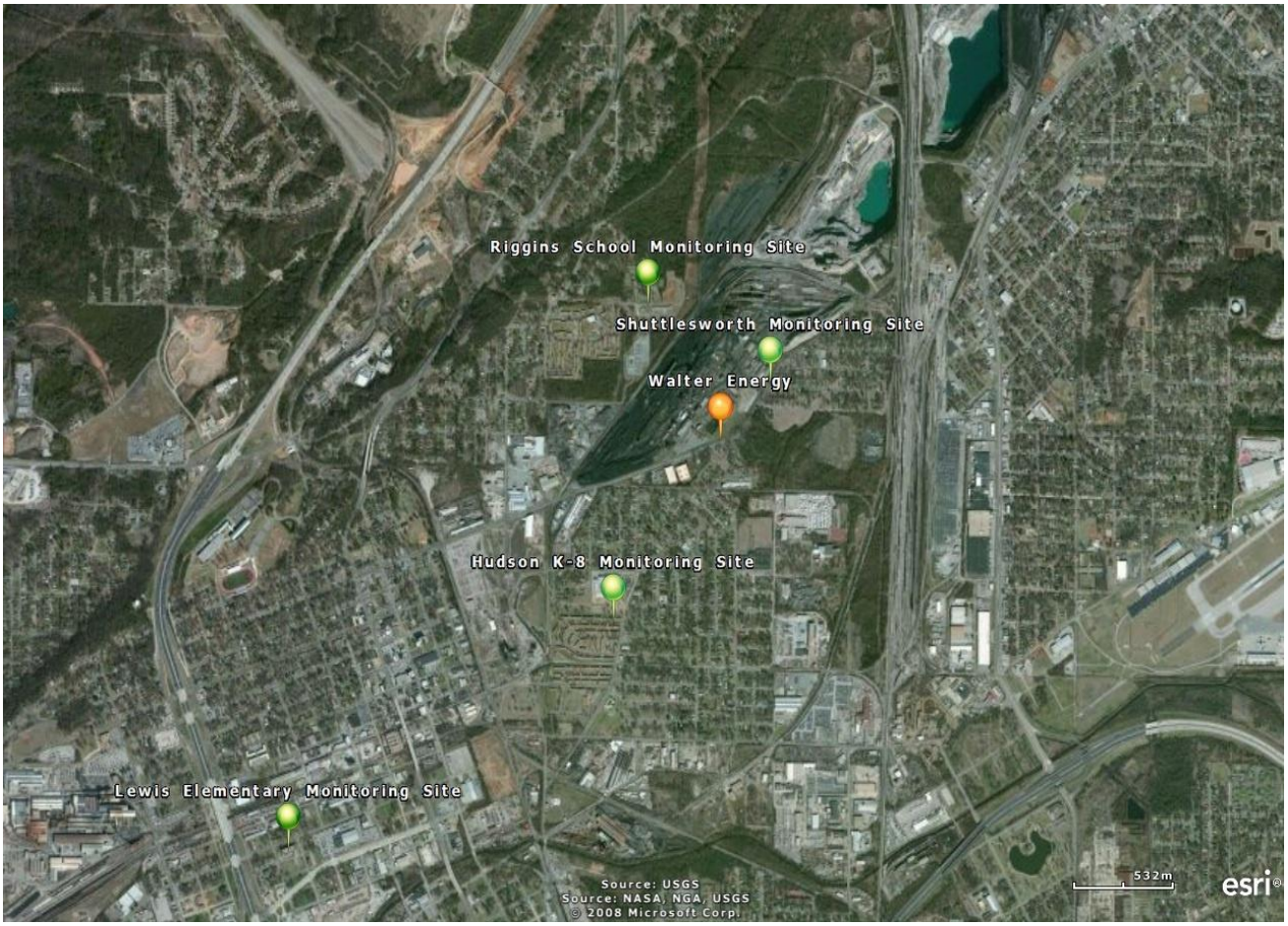


Figure 2.1-1. Approximate Locations of the 4 Monitoring Sites



Tables

Table 1.2-1 Monthly Weather Conditions Data For the Monitoring Time Period[1]

Year/ Month	Temperature (°F)[2]			Temperature (°F) -Deviation from Normal			Rainfall (inches)		Ave Wind Speed (mph)
	Min	Max	Ave	Min	Max	Ave	Amount	Deviation From Normal	
11-Jun	70.5	94.7	82.6	7	2.8	4.9	2.81	-1.57	5.4
11-Jul	73.6	92.5	83.1	1.7	2.2	2	8	3.2	4
11-Aug	71.8	94.6	83.2	4	1	2.5	0.48	-3.45	4.3
11-Sep	61.8	82.7	72.3	-2.4	-2.5	-2.4	12.14	8.24	4.9
11-Oct	49	73.4	61.2	-1.9	-3.9	-2.9	0.36	-3.08	4.9
11-Nov	45.6	66.1	55.9	0.7	2.1	1.5	6.37	1.52	7
11-Dec	39.5	59.6	49.6	3.7	3.2	3.5	5.24	0.79	5.3
12-Jan	38.8	60.7	49.8	6.9	5	6	5.9	1.06	6.7
12-Feb	42.3	61.6	52	3.2	5.2	4.3	2.96	-1.6	6.7
12-Mar	54.8	76.3	65.6	9.6	11.1	10.4	4.72	-0.5	6.6
12-Apr	54.5	77.7	66.1	3.3	4	3.6	1.26	-3.2	6.0
12-May	63.8	84.5	74.2	3	4.1	3.6	4.95	-0.04	4.0
12-Jun	67.7	89.9	78.8	2.2	0.0	1.1	2.44	-1.9	4.7
12-Jul	73.9	92.9	83.4	2.1	2.5	2.3	6.26	1.5	5.1
12-Aug	69.8	87.2	78.5	-3.4	-1.0	-2.2	4.07	0.14	4.1

[1]As Recorded at the Birmingham International Airport
[2]Min = Minimum, Max = maximum; Ave = Average

Table 2.2-1 Sample Analysis List for All Monitoring Sites

Chemical	CAS #	TYPE	Chemical	CAS #	TYPE
1,1,1-Trichloroethane	71-55-6	VOC	Coronene	191-07-1	SVOCs
1,1,2,2-Tetrachloroethane	79-34-5	VOC	Cyclopenta[cd]pyrene	27208-37-3	SVOCs
1,1,2-Trichloroethane	79-00-5	VOC	Dibenz (a,h) anthracene	53-70-3	SVOCs
1,1-Dichloroethane	75-34-3	VOC	Dibromochloromethane	124-48-1	VOC
1,1-Dichloroethene	75-35-4	VOC	Dichlorodifluoromethane	75-71-8	VOC
1,2,4-Trichlorobenzene	120-82-1	VOC	Dichloromethane	75-09-2	VOC
1,2,4-Trimethylbenzene	95-63-6	VOC	Dichlorotetrafluoroethane	76-14-2	VOC
1,2-Dibromoethane	106-93-4	VOC	Ethyl Acrylate	140-88-5	VOC
1,2-Dichloroethane	107-06-2	VOC	Ethyl tert-Butyl Ether	637-92-3	VOC
1,2-Dichloropropane	78-87-5	VOC	Ethylbenzene	100-41-4	VOC
1,3,5-Trimethylbenzene	108-67-8	VOC	Fluoranthene	206-44-0	SVOCs
1,3-Butadiene	106-99-0	VOC	Fluorene	86-73-7	SVOCs
9-Fluorenone	486-25-9	SVOCs	Hexachloro-1,3-Butadiene	87-68-3	VOC
Acenaphthene	83-32-9	SVOCs	Indeno(1,2,3-cd)pyrene	193-39-5	SVOCs
Acenaphthylene	208-96-8	SVOCs	Lead	7439-92-1	Metal
Acetonitrile	75-05-8	VOC	m,p-Xylene	108-38-3, 106-42-3	VOC
Acetylene	74-86-2	VOC	Manganese	7439-96-5	Metal
Acrolein	107-02-8	VOC	m-Dichlorobenzene	541-73-1	VOC
Acrylonitrile	107-13-1	VOC	Mercury	7439-97-6	Metal
Anthracene	120-12-7	SVOCs	Methyl Ethyl Ketone[1]	78-93-3	VOC
Antimony	7440-36-0	Metal	Methyl Isobutyl Ketone	108-10-1	VOC
Arsenic	7440-38-2	Metal	Methyl Methacrylate	80-62-6	VOC
Benzene	71-43-2	VOC	Methyl tert-Butyl Ether	1634-04-4	VOC
Benzo (a) anthracene	56-55-3	SVOCs	Naphthalene	91-20-3	SVOCs
Benzo (a) pyrene	50-32-8	SVOCs	Nickel	7440-02-0	Metal
Benzo (b) fluoranthene	205-99-2	SVOCs	n-Octane	111-65-9	VOC
Benzo (e) pyrene	192-97-2	SVOCs	o-Dichlorobenzene	95-50-1	VOC
Benzo (g,h,i) perylene	191-24-2	SVOCs	o-Xylene	95-47-6	VOC
Benzo (k) fluoranthene	207-08-9	SVOCs	p-Dichlorobenzene	106-46-7	VOC
Beryllium	7440-41-7	Metal	Perylene	198-55-0	SVOCs
Bromochloromethane	74-97-5	VOC	Phenanthrene	85-01-8	SVOCs
Bromodichloromethane	75-27-4	VOC	Propylene	115-07-1	VOC
Bromoform	75-25-2	VOC	Pyrene	129-00-0	SVOCs
Bromomethane	74-83-9	VOC	Retene	483-65-8	SVOCs
Cadmium	7440-43-9	Metal	Selenium	7782-49-2	Metal
Carbon Disulfide	75-15-0	VOC	Styrene	100-42-5	VOC
Carbon Tetrachloride	56-23-5	VOC	tert-Amyl Methyl Ether	994-05-8	VOC

Chemical	CAS #	TYPE	Chemical	CAS #	TYPE
Chlorobenzene	108-90-7	VOC	Tetrachloroethylene	127-18-4	VOC
Chloroethane	75-00-3	VOC	Toluene	108-88-3	VOC
Chloroform	67-66-3	VOC	Total Chromium	7440-47-3	Metal
Chloromethane	74-87-3	VOC	trans-1,2-Dichloroethylene	156-60-5	VOC
Chloroprene	126-99-8	VOC	trans-1,3-Dichloropropene	10061-02-6	VOC
Chrysene	218-01-9	SVOCs	Trichloroethylene	79-01-6	VOC
cis-1,2-Dichloroethylene	156-59-2	VOC	Trichlorofluoromethane	75-69-4	VOC
cis-1,3-Dichloropropene	10061-01-5	VOC	Trichlorotrifluoroethane	76-13-1	VOC
Cobalt	7440-48-4	Metal	Vinyl chloride	75-01-4	VOC

[1]ERG discontinued laboratory analysis for Methyl Ethyl Ketone (CAS# 78-93-3) in December 2011. Its concentration has been seen to increase over time in repeated analysis in the same canister (personal communication with ERG staff).

Table 2.3.1-1 Sampling Dates at Each of the Monitoring Sites

Monitoring Sites			
Hudson K-8 School	**Lewis Elementary School**	**Riggins School**	**Shuttlesworth Station**
6/24/2011	6/24/2011	6/24/2011	6/24/2011
7/7/2011	7/7/2011	7/7/2011	7/7/2011
-[1]	7/8/2011	-	7/8/2011
7/13/2011	7/13/2011	7/13/2011	7/13/2011
7/19/2011	7/19/2011	7/19/2011	7/19/2011
7/20/2011	7/20/2011	-	7/20/2011
-	-	7/24/2011	-
7/25/2011	7/25/2011	7/25/2011	7/25/2011
7/31/2011	7/31/2011	7/31/2011	7/31/2011
8/1/2011	8/1/2011	-	8/1/2011
8/6/2011	8/6/2011	8/6/2011	8/6/2011
8/12/2011	8/12/2011	8/12/2011	8/12/2011
8/18/2011	8/18/2011	8/18/2011	8/18/2011
8/24/2011	8/24/2011	8/24/2011	8/24/2011
8/30/2011	8/30/2011	8/30/2011	8/30/2011
9/11/2011	9/11/2011	9/11/2011	9/11/2011
9/12/2011	9/12/2011	-	-
9/17/2011	9/17/2011	9/17/2011	9/17/2011
9/23/2011	9/23/2011	9/23/2011	9/23/2011
9/29/2011	9/29/2011	9/29/2011	9/29/2011
10/5/2011	10/5/2011	10/5/2011	10/5/2011
10/11/2011	10/11/2011	10/11/2011	10/11/2011
10/17/2011	10/17/2011	10/17/2011	10/17/2011
10/23/2011	10/23/2011	10/23/2011	10/23/2011
10/29/2011	10/29/2011	10/29/2011	10/29/2011
11/4/2011	11/4/2011	11/4/2011	11/4/2011
11/10/2011	11/10/2011	11/10/2011	11/10/2011
11/16/2011	11/16/2011	11/16/2011	11/16/2011
11/22/2011	11/22/2011	11/22/2011	11/22/2011
11/28/2011	11/28/2011	11/28/2011	11/28/2011
12/4/2011	12/4/2011	12/4/2011	12/4/2011
12/10/2011	12/10/2011	12/10/2011	12/10/2011
12/16/2011	12/16/2011	12/16/2011	12/16/2011
12/22/2011	12/22/2011	12/22/2011	12/22/2011
1/9/2012	1/9/2012	1/9/2012	1/9/2012
1/15/2012	1/15/2012	1/15/2012	1/15/2012

Monitoring Sites			
Hudson K-8 School	**Lewis Elementary School**	**Riggins School**	**Shuttlesworth Station**
1/21/2012	1/21/2012	1/21/2012	1/21/2012
1/28/2012	1/28/2012	1/28/2012	1/28/2012
2/2/2012	2/2/2012	2/2/2012	2/2/2012
2/8/2012	2/8/2012	2/8/2012	2/8/2012
2/14/2012	2/14/2012	2/14/2012	2/14/2012
2/20/2012	2/20/2012	2/20/2012	2/20/2012
2/26/2012	2/26/2012	2/26/2012	2/26/2012
2/27/2012	-	-	2/27/2012
3/3/2012	3/3/2012	3/3/2012	3/3/2012
3/9/2012	3/9/2012	3/9/2012	3/9/2012
3/15/2012	3/15/2012	3/15/2012	3/15/2012
3/21/2012	3/21/2012	3/21/2012	3/21/2012
3/27/2012	3/27/2012	3/27/2012	3/27/2012
4/2/2012	4/2/2012	4/2/2012	4/2/2012
4/8/2012	4/8/2012	4/8/2012	4/8/2012
4/14/2012	4/14/2012	4/14/2012	4/14/2012
4/20/2012	4/20/2012	4/20/2012	4/20/2012
4/26/2012	4/26/2012	4/26/2012	4/26/2012
5/2/2012	5/2/2012	5/2/2012	5/2/2012
5/8/2012	5/8/2012	5/8/2012	5/8/2012
5/14/2012	5/14/2012	5/14/2012	5/14/2012
5/20/2012	5/20/2012	5/20/2012	5/20/2012
5/26/2012	5/26/2012	5/26/2012	5/26/2012
6/1/2012	6/1/2012	6/1/2012	6/1/2012
6/7/2012	6/7/2012	6/7/2012	6/7/2012
6/13/2012	6/13/2012	6/13/2012	6/13/2012
6/19/2012	6/19/2012	6/19/2012	6/19/2012
6/25/2012	6/25/2012	6/25/2012	6/25/2012
7/1/2012	7/1/2012	7/1/2012	7/1/2012
7/4/2012	7/4/2012	7/4/2012	7/4/2012
7/7/2012	7/7/2012	7/7/2012	7/7/2012
7/10/2012	7/10/2012	7/10/2012	7/10/2012
7/13/2012	7/13/2012	7/13/2012	7/13/2012
7/16/2012	7/16/2012	7/16/2012	7/16/2012
7/21/2012	7/21/2012	7/21/2012	7/21/2012
7/24/2012	7/24/2012	7/24/2012	7/24/2012
-	-	-	7/26/2012

Monitoring Sites			
Hudson K-8 School	**Lewis Elementary School**	**Riggins School**	**Shuttlesworth Station**
7/27/2012	7/27/2012	7/27/2012	-
7/30/2012	-	7/30/2012	7/30/2012
7/31/2012	-	-	-
8/2/2012	8/2/2012	8/2/2012	-
8/5/2012	8/5/2012	-	-
-	8/8/2012	8/8/2012	-
-	8/11/2012	-	-
-	-	8/17/2012	-
-	-	8/20/2012	-
-	-	8/23/2012	-
-	-	8/26/2012	-

[1]Samples missed or invalidated. For more information as to why, see Section 2.3.1 of this document

Table 2.6-1 Chemical Screening Results for the Hudson K-8 School Site

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
1,1,1-Trichloroethane	VOC	71-55-6	0.12004	0.22371	0.17187	60	2	3	
1,1,2,2-Tetrachloroethane	VOC	79-34-5	0.71396	0.71396	0.71396	60	1	2	
1,1,2-Trichloroethane	VOC	79-00-5	0.22916	0.22916	0.22916	60	1	2	
1,1-Dichloroethane	VOC	75-34-3	0.15380	0.15380	0.15380	60	1	2	
1,1-Dichloroethene	VOC	75-35-4	0.04361	0.13084	0.08723	60	2	3	
1,2,4-Trichlorobenzene	VOC	120-82-1	0.97218	0.97218	0.97218	60	1	2	
1,2-Dibromoethane	VOC	106-93-4	0.38418	0.38418	0.38418	60	1	2	
1,2-Dichloroethane	VOC	107-06-2	0.06476	0.22666	0.09431	60	43	72	X
1,2-Dichloropropane	VOC	78-87-5	0.19409	0.19409	0.19409	60	1	2	
1,3-Butadiene	VOC	106-99-0	0.02655	0.64157	0.13871	60	60	100	X
Acetonitrile	VOC	75-05-8	0.06548	3.59313	0.38705	60	58	97	X
Acrylonitrile	VOC	107-13-1	0.10200	0.25609	0.17905	60	2	3	
Arsenic	Metal	7440-38-2	0.00013	0.00400	0.00151	63	63	100	X
Benzene	VOC	71-43-2	0.00013	21.88453	3.44210	60	60	100	X
Benzo(a)anthracene	SVOC	56-55-3	0.00005	0.01610	0.00230	68	62	91	X
Benzo(a)pyrene	SVOC	50-32-8	0.00006	0.00955	0.00154	68	47	69	X
Benzo(b)fluoranthene	SVOC	205-99-2	0.00006	0.01930	0.00280	68	68	100	X
Benzo(k)fluoranthene	SVOC	207-08-9	0.00005	0.00545	0.00107	68	51	75	X
Beryllium	Metal	7440-41-7	0.00001	0.00008	0.00002	63	35	56	X
Bromoform	VOC	75-25-2	0.85794	0.85794	0.85794	60	1	2	
Bromomethane	VOC	74-83-9	0.03883	0.14755	0.06130	60	42	70	X
Cadmium	Metal	7440-43-9	0.00008	0.00779	0.00089	63	63	100	X
Carbon Disulfide	VOC	75-15-0	0.04360	0.27092	0.08732	60	25	42	X
Carbon Tetrachloride	VOC	56-23-5	0.04360	0.89966	0.70002	60	60	100	X
Chlorobenzene	VOC	108-90-7	0.11969	0.29924	0.18261	60	3	5	

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
Chloroethane	VOC	75-00-3	0.10027	0.10818	0.10379	60	3	5	
Chloroform	VOC	67-66-3	0.07324	0.28807	0.15272	60	43	72	X
Chloromethane	VOC	74-87-3	0.07324	1.76139	1.22334	60	60	100	X
Chloroprene	VOC	126-99-8	0.14484	0.14484	0.14484	60	1	2	
Chrysene	SVOC	218-01-9	0.00013	0.01660	0.00289	68	68	100	X
Cobalt	Metal	7440-48-4	0.00005	0.00122	0.00024	63	63	100	X
Dibenz(a,h)anthracene	SVOC	53-70-3	0.00006	0.00225	0.00045	68	39	57	X
Dichloromethane	VOC	75-09-2	0.28137	4.82849	0.77157	60	60	100	X
Ethylbenzene	VOC	100-41-4	0.10856	1.81070	0.51144	60	60	100	X
Hexachloro-1,3-Butadiene	VOC	87-68-3	1.16250	1.16250	1.16250	60	1	2	
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5	0.00006	0.00712	0.00122	68	53	78	X
Lead	Metal	7439-92-1	0.00006	1.13000	0.05286	63	63	100	X
m, p-Xylenes	VOC	108-38-3, 106-42-3	0.00006	6.90411	1.49082	60	60	100	X
Manganese	Metal	7439-96-5	0.00006	0.11700	0.03095	63	63	100	X
Mercury	Metal	7439-97-6	0.00002	0.00028	0.00006	63	20	32	X
Methyl Isobutyl Ketone	VOC	108-10-1	0.06554	0.51616	0.21234	60	54	90	X
Methyl Methacrylate	VOC	80-62-6	0.14332	0.28254	0.21293	60	2	3	
Methyl tert-Butyl Ether	VOC	1634-04-4	0.11176	0.11176	0.11176	60	1	2	
Naphthalene	SVOC	91-20-3	0.03750	2.02000	0.48373	68	68	100	X
Nickel	Metal	7440-02-0	0.00055	0.01260	0.00234	63	60	95	X
o-Xylene	VOC	95-47-6	0.108555	2.848489	0.626146	61	61	100	X
p-Dichlorobenzene	VOC	106-46-7	0.11424	0.94395	0.31522	60	28	47	X
Propylene	VOC	115-07-1	0.0000642	4.06174	0.95270	60	60	100	X
Selenium	Metal	7782-49-2	0.00021	0.00223	0.00089	63	57	90	X
Styrene	VOC	100-42-5	0.11075	4.43015	0.63288	60	56	93	X
Tetrachloroethylene	VOC	127-18-4	0.12887	0.83426	0.25587	60	29	48	X

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
Toluene	VOC	108-88-3	0.12887	27.43479	3.24394	60	60	100	X
Total Chromium	Metal	7440-47-3	0.00831	0.01780	0.01380	63	18	29	X
Trichloroethylene	VOC	79-01-6	0.13434	0.24719	0.17375	60	6	10	X
Vinyl chloride	VOC	75-01-4	0.02301	0.07669	0.04175	60	3	5	

[1]Chemicals that were detected at or above respective detection limits at least once.
[2]X- Retained as COPC since detected at or above the detection limit in at least 10 percent of the samples

Table 2.6-2 Chemical Screening Results for the Lewis Elementary School Site

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC [2]
1,1,1-Trichloroethane	VOC	71-55-6	0.12004	0.13095	0.12549	61	3	5	
1,1-Dichloroethene	VOC	75-35-4	0.04361	0.04361	0.04361	61	1	2	
1,2-Dichloroethane	VOC	107-06-2	0.06881	0.14975	0.10198	61	46	75	X
1,3-Butadiene	VOC	106-99-0	0.03318	0.60618	0.15453	61	60	98	X
Acetonitrile	VOC	75-05-8	0.08059	1.44565	0.33242	61	56	92	X
Acrylonitrile	VOC	107-13-1	0.31252	0.31252	0.31252	61	1	2	
Arsenic	Metal	7440-38-2	0.00017	0.00465	0.00146	66	66	100	X
Benzene	VOC	71-43-2	0.00017	20.44686	2.89021	61	61	100	X
Benzo(a)anthracene	SVOC	56-55-3	0.00005	0.03010	0.00288	62	58	94	X
Benzo(a)pyrene	SVOC	50-32-8	0.00005	0.01530	0.00212	62	42	68	X
Benzo(b)fluoranthene	SVOC	205-99-2	0.00007	0.03190	0.00337	62	61	98	X
Benzo(k)fluoranthene	SVOC	207-08-9	0.00005	0.01060	0.00142	62	45	73	X
Beryllium	Metal	7440-41-7	0.00001	0.00008	0.00003	66	37	56	X
Bromomethane	VOC	74-83-9	0.03883	0.10096	0.05996	61	43	70	X
Cadmium	Metal	7440-43-9	0.00004	0.00668	0.00072	66	66	100	X
Carbon Disulfide	VOC	75-15-0	0.04360	0.19930	0.08944	61	25	41	X
Carbon Tetrachloride	VOC	56-23-5	0.04360	0.98774	0.71453	61	61	100	X
Chloroethane	VOC	75-00-3	0.04750	0.19790	0.10357	61	4	7	
Chloroform	VOC	67-66-3	0.07812	0.30272	0.15291	61	41	67	X
Chloromethane	VOC	74-87-3	0.07812	1.86670	1.26378	61	61	100	X
Chrysene	SVOC	218-01-9	0.00011	0.03150	0.00346	62	62	100	X
Cobalt	Metal	7440-48-4	0.00004	0.00056	0.00020	66	66	100	X
Dibenz(a,h)anthracene	SVOC	53-70-3	0.00005	0.00349	0.00072	62	27	44	X
Dichloromethane	VOC	75-09-2	0.25358	3.34173	0.74344	61	61	100	X
Ethylbenzene	VOC	100-41-4	0.10856	4.47247	0.86196	61	61	100	X

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC [2]
Hexachloro-1,3-Butadiene	VOC	87-68-3	0.43727	0.43727	0.43727	61	1	2	
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5	0.00005	0.00987	0.00149	62	46	74	X
m,p-Xylenes	VOC	108-38-3, 106-42-3	0.00005	0.83500	0.02754	61	61	100	X
Lead	Metal	7439-92-1	0.00005	0.83500	0.02755	66	66	100	X
Manganese	Metal	7439-96-5	0.00005	0.16500	0.03422	66	66	100	X
Mercury	Metal	7439-97-6	0.00002	0.00009	0.00003	66	19	29	X
Methyl Isobutyl Ketone	VOC	108-10-1	0.07783	0.98317	0.30469	61	53	87	X
Naphthalene	SVOC	91-20-3	0.02030	1.83000	0.45615	62	62	100	X
Nickel	Metal	7440-02-0	0.00055	0.01040	0.00270	66	62	94	X
o-Xylenes	VOC	95-47-6	0.09987	7.51202	1.10306	61	61	100	X
p-Dichlorobenzene	VOC	106-46-7	0.12025	0.62529	0.26767	61	25	41	X
Propylene	VOC	115-07-1	0.00008	4.457597	1.21776	61	61	100	X
Selenium	Metal	7782-49-2	0.00007	0.00224	0.00079	66	58	88	X
Styrene	VOC	100-42-5	0.11075	3.02443	0.49924	61	55	90	X
Tetrachloroethylene	VOC	127-18-4	0.13565	0.80034	0.29246	61	42	69	X
Toluene	VOC	108-88-3	0.13565	105.14158	4.41726	61	61	100	X
Total Chromium	Metal	7440-47-3	0.00822	0.02610	0.01397	66	18	27	X
Trichloroethylene	VOC	79-01-6	0.11822	0.27944	0.18540	61	8	13	X
Vinyl chloride	VOC	75-01-4	0.02812	0.04090	0.03579	61	3	5	

[1]Chemicals that were detected at or above respective detection limits at least once.
[2]X- Retained as COPC since detected at or above the detection limit in at least 10 percent of the samples

Table 2.6-3 Chemical Screening Results for the Riggins School Site

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
1,1-Dichloroethane	VOC	75-34-3	0.04250	0.04452	0.04351	65	2	3	
1,2,4-Trichlorobenzene	VOC	120-82-1	1.16513	1.16513	1.16513	65	1	2	
1,2-Dichloroethane	VOC	107-06-2	0.06881	0.13660	0.09651	65	47	72	X
1,3-Butadiene	VOC	106-99-0	0.02710	0.91978	0.17245	65	63	97	X
Acetonitrile	VOC	75-05-8	0.11040	9.04160	0.58497	65	62	95	X
Acrylonitrile	VOC	107-13-1	0.11611	0.88113	0.50980	65	5	8	
Arsenic	Metal	7440-38-2	0.00023	0.01075	0.00233	67	66	99	X
Benzene	VOC	71-43-2	0.00023	55.11068	6.09708	65	65	100	X
Benzo(a)anthracene	SVOC	56-55-3	0.00006	0.03853	0.00692	71	71	100	X
Benz (a)pyrene	SVOC	50-32-8	0.00006	0.02148	0.00417	71	59	83	X
Benzo(b)fluoranthene	SVOC	205-99-2	0.00006	0.04710	0.00828	71	71	100	X
Benzo(k)fluoranthene	SVOC	207-08-9	0.00005	0.01323	0.00285	71	62	87	X
Beryllium	Metal	7440-41-7	0.00001	0.00008	0.00003	67	36	54	X
Bromomethane	VOC	74-83-9	0.04271	0.44654	0.07177	65	47	72	X
Cadmium	Metal	7440-43-9	0.00005	0.00274	0.00048	67	67	100	X
Carbon Disulfide	VOC	75-15-0	0.04515	0.46867	0.13268	65	38	58	X
Carbon Tetrachloride	VOC	56-23-5	0.04515	0.96572	0.69313	65	65	100	X
Chlorobenzene	VOC	108-90-7	0.09783	11.39396	2.37363	65	5	8	
Chloroethane	VOC	75-00-3	0.06333	0.35753	0.16360	65	6	9	
Chloroform	VOC	67-66-3	0.07446	0.25389	0.13321	65	52	80	X
Chloromethane	VOC	74-87-3	0.07446	20.63904	1.55923	65	65	100	X
Chrysene	VOC	218-01-9	0.00017	0.04620	0.00882	71	71	100	X
Cobalt	Metal	7440-48-4	0.00004	0.00067	0.00020	67	67	100	X
Dibenz(a,h)anthracene	SVOC	53-70-3	0.00006	0.00469	0.00110	71	52	73	X
Dichloromethane	VOC	75-09-2	0.21103	5.47634	0.83461	65	65	100	X

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
Ethylbenzene	VOC	100-41-4	0.04597	3.60186	0.45773	65	65	100	X
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5	0.00006	0.01573	0.00327	71	60	85	X
Lead	Metal	7439-92-1	0.00006	0.06730	0.01340	67	67	100	X
m,p-Xylenes	VOC	108-38-3, 106-42-3	0.000056	7.18636	1.32945	65	65	100	X
Manganese	Metal	7439-96-5	0.00006	0.05760	0.01669	67	67	100	X
Mercury	Metal	7439-97-6	0.00002	0.00053	0.00007	67	23	34	X
Methyl Isobutyl Ketone	VOC	108-10-1	0.08193	0.43014	0.18016	65	53	82	X
Methyl Methacrylate	VOC	80-62-6	0.19245	3.04446	1.61846	65	2	3	
Methyl tert-Butyl Ether	VOC	1634-04-4	0.06850	0.06850	0.06850	65	1	2	
Naphthalene	SVOC	91-20-3	0.03430	5.73500	0.87183	71	71	100	X
Nickel	Metal	7440-02-0	0.00053	0.01210	0.00274	67	64	96	X
o-Xylenes	VOC	95-47-6	0.0966	4.4508	0.57012	65	65	100	X
p-Dichlorobenzene	VOC	106-46-7	0.11424	1.27463	0.23328	65	15	23	X
Propylene	VOC	115-07-1	0.000077	9.85318	1.23060	65	65	100	X
Selenium	Metal	7782-49-2	0.00015	0.00304	0.00103	67	64	96	X
Styrene	VOC	100-42-5	0.10756	3.71451	0.64878	65	62	95	X
Tetrachloroethylene	VOC	127-18-4	0.12378	2.72320	0.28738	65	31	48	X
Toluene	VOC	108-88-3	0.12378	31.80627	3.07301	65	65	100	X
Total Chromium	Metal	7440-47-3	0.01030	0.01660	0.01374	67	14	21	X
Trichloroethylene	VOC	79-01-6	0.16659	0.53200	0.30362	65	3	5	
Vinyl chloride	VOC	75-01-4	0.02045	0.08052	0.03579	65	5	8	

[1]Chemicals that were detected at or above respective detection limits at least once.
[2]X- Retained as COPC since detected at or above the detection limit in at least 10 percent of the samples

Table 2.6-4 Chemical Screening Results for the Shuttlesworth Station Site

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
1,1,1-Trichloroethane	VOC	71-55-6	0.10912	0.30009	0.18006	60	3	5	
1,1-Dichloroethene	VOC	75-35-4	0.0555	0.0555	0.0555	60	1	2	
1,2-Dichloroethane	VOC	107-06-2	0.0648	0.8621	0.1175	60	48	80	X
1,3-Butadiene	VOC	106-99-0	0.0310	0.4933	0.1493	60	60	100	X
Acetonitrile	VOC	75-05-8	0.0823	0.6061	0.2843	60	54	90	X
Acrylonitrile	VOC	107-13-1	0.0760	1.3629	0.8551	60	3	5	
Arsenic	Metal	7440-38-2	0.0004	0.0075	0.0024	62	60	97	X
Benzene	VOC	71-43-2	0.0004	22.7152	4.1336	60	60	100	X
Benzo(a)anthracene	SVOC	56-55-3	0.0001	0.0137	0.0033	68	68	100	X
Benzo(a)pyrene	SVOC	50-32-8	0.0001	0.0075	0.0017	68	61	90	X
Benzo(b)fluoranthene	SVOC	205-99-2	0.0001	0.0153	0.0040	68	68	100	X
Benzo(k)fluoranthene	SVOC	207-08-9	0.0001	0.0044	0.0013	68	63	93	X
Beryllium	Metal	7440-41-7	0.0000	0.0001	0.0000	62	37	60	X
Bromomethane	VOC	74-83-9	0.0388	0.1010	0.0608	60	43	72	X
Cadmium	Metal	7440-43-9	0.0000	0.0025	0.0004	62	62	100	X
Carbon Disulfide	VOC	75-15-0	0.0436	0.1837	0.0881	60	32	53	X
Carbon Tetrachloride	VOC	56-23-5	0.0436	0.9374	0.7136	60	60	100	X
Chloroethane	VOC	75-00-3	0.0396	0.0396	0.0396	60	1	2	
Chloroform	VOC	67-66-3	0.0928	0.8056	0.1753	60	43	72	X
Chloromethane	VOC	74-87-3	0.0928	1.7593	1.2081	60	60	100	X
Chloroprene	VOC	126-99-8	0.2643	0.2643	0.2643	60	1	2	
Chrysene	SVOC	218-01-9	0.0003	0.0163	0.0045	68	68	100	X
Cobalt	Metal	7440-48-4	0.0001	0.0006	0.0002	62	60	97	X
Dibenz(a,h)anthracene	SVOC	53-70-3	0.0001	0.0018	0.0005	68	52	76	X
Dichloromethane	VOC	75-09-2	0.1533	23.1698	1.0396	60	60	100	X

Chemical[1]	Chemical Type	CAS #	Min Conc. (µg/m^3)	Max Conc. (µg/m^3)	Ave Conc. (µg/m^3)	Number of Valid Samples	Number of Detections (≥1)	Detection Frequency (%)	COPC[2]
Ethylbenzene	VOC	100-41-4	0.0501	1.8454	0.4952	60	60	100	X
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5	0.0001	0.0050	0.0014	68	65	96	X
Lead	Metal	7439-92-1	0.0001	0.0432	0.0108	62	62	100	X
m,p-Xylenes	VOC	108-38-3, 106-42-3	0.00006	7.42518	1.44632	60	60	100	X
Manganese	Metal	7439-96-5	0.0001	0.0607	0.0228	62	62	100	X
Mercury	Metal	7439-97-6	0.0000	0.0001	0.0001	62	16	26	X
Methyl Isobutyl Ketone	VOC	108-10-1	0.0737	0.6800	0.2026	60	50	83	X
Methyl tert-Butyl Ether	VOC	1634-04-4	0.0541	0.0541	0.0541	60	1	2	
Naphthalene	SVOC	91-20-3	0.0465	2.0600	0.6951	68	68	100	X
Nickel	Metal	7440-02-0	0.0007	0.0122	0.0030	62	59	95	X
o-Xylenes	VOC	95-47-6	0.09553	3.0135	0.6006	60	60	100	X
p-Dichlorobenzene	VOC	106-46-7	0.1142	0.7936	0.3000	60	29	48	X
Propylene	VOC	115-07-1	0.00006	2.54719	1.012397	60	60	100	X
Selenium	Metal	7782-49-2	0.0002	0.0024	0.0009	62	56	90	X
Styrene	VOC	100-42-5	0.1108	4.3024	0.7642	60	56	93	X
Tetrachloroethylene	VOC	127-18-4	0.1221	0.7393	0.2541	60	32	53	X
Toluene	VOC	108-88-3	0.1221	15.5263	2.8899	60	60	100	X
Total Chromium	Metal	7440-47-3	0.0097	0.0304	0.0163	62	16	26	X
Trichloroethylene	VOC	79-01-6	0.2203	0.2257	0.2230	60	2	3	
Vinyl chloride	VOC	75-01-4	0.0204	0.0358	0.0275	60	4	7	

[1]Chemicals that were detected at or above respective detection limits at least once.
[2]X- Retained as COPC since detected at or above the detection limit in at least 10 percent of the samples

Table 2.6-5 Comparison of Monitoring Sites in the Number of Chemicals of Potential Concern

Monitoring Site	Type and Number of Chemicals						Total Number of COPCs
	VOCs		SVOCs		Metals		
	Total	COPCs	Total	COPCs	Total	COPCs	
Hudson K-8 School	58	20	22	8	11	10	38
Lewis Elementary School	58	20	22	8	11	10	38
Riggins School	58	20	22	7	11	10	37
Shuttlesworth Station	58	19	22	8	11	10	37

Table 2.6-6 Comparison of Monitoring Sites in Maximum Concentrations and Detection Frequency for COPCs

Chemical			Maximum Concentration (µg/m^3)[1]				Detection Frequency (%)			
Name	**Type**	**CAS #**	**HEAL**	**LEAL**	**RSAL**	**SLOSS**	**HEAL**	**LEAL**	**RSAL**	**SLOSS**
1,2-Dichloroethane	VOC	107-06-2	0.22666	0.14975	0.13660	0.8621	72	75	72	80
1,3-Butadiene	VOC	106-99-0	0.64157	0.60618	0.91978	0.4933	100	98	97	100
Acetonitrile	VOC	75-05-8	3.59313	1.44565	9.04160	0.6061	97	92	95	90
Arsenic	Metal	7440-38-2	0.00400	0.00465	0.01075	0.0075	100	100	99	97
Benzene	VOC	71-43-2	21.88453	20.44686	55.11068	22.7152	100	100	100	100
Benzo(a)anthracene	SVOC	56-55-3	0.01610	0.03010	0.03853	0.0137	91	94	100	100
Benzo(a)pyrene	SVOC	50-32-8	0.00955	0.01530	0.02148	0.0075	69	68	83	90
Benzo(b)fluoranthene	SVOC	205-99-2	0.01930	0.03190	0.04710	0.0153	100	98	100	100
Benzo(k)fluoranthene	SVOC	207-08-9	0.00545	0.01060	0.01323	0.0044	75	73	87	93
Beryllium	Metal	7440-41-7	0.00008	0.00008	0.00008	0.0001	56	56	54	60
Bromomethane	VOC	74-83-9	0.14755	0.10096	0.44654	0.1010	70	70	72	72
Cadmium	Metal	7440-43-9	0.00779	0.00668	0.00274	0.0025	100	100	100	100
Carbon Disulfide	VOC	75-15-0	0.27092	0.19930	0.46867	0.1837	42	41	58	53
Carbon Tetrachloride	VOC	56-23-5	0.89966	0.98774	0.96572	0.9374	100	100	100	100
Chloroform	VOC	67-66-3	0.28807	0.30272	0.25389	0.8056	72	67	80	72
Chloromethane	VOC	74-87-3	1.76139	1.86670	20.63904	1.7593	100	100	100	100
Chrysene	SVOC	218-01-9	0.01660	0.03150	0.04620	0.0163	100	100	100	100
Cobalt	Metal	7440-48-4	0.00122	0.00056	0.00067	0.0006	100	100	100	97
Dibenz(a,h)anthracene	SVOC	53-70-3	0.00225	0.00349	0.00469	0.0018	57	44	73	76
Dichloromethane	VOC	75-09-2	4.82849	3.34173	5.47634	23.1698	100	100	100	100
Ethylbenzene	VOC	100-41-4	1.81070	4.47247	3.60186	1.8454	100	100	100	100
Indeno(1,2,3-cd)pyrene	SVOC	193-39-5	0.00712	0.00987	0.01573	0.0050	78	74	85	96
Lead	Metal	7439-92-1	1.13000	0.83500	0.06730	0.0432	100	100	100	100
m,p-Xylenes	VOC	108-38-3, 106-42-3	6.60411	0.83500	7.18636	7.42518	100	100	100	100
Manganese	Metal	7439-96-5	0.11700	0.16500	0.05760	0.0607	100	100	100	100

Chemical			Maximum Concentration (µg/m^3)[1]				Detection Frequency (%)			
Name	**Type**	**CAS #**	**HEAL**	**LEAL**	**RSAL**	**SLOSS**	**HEAL**	**LEAL**	**RSAL**	**SLOSS**
Mercury	Metal	7439-97-6	0.00028	0.00009	0.00053	0.0001	32	29	34	26
Methyl Isobutyl Ketone	VOC	108-10-1	0.51616	0.98317	0.43014	0.6800	90	87	82	83
Naphthalene	SVOC	91-20-3	2.02000	1.83000	5.73500	2.0600	100	100	100	100
Nickel	Metal	7440-02-0	0.01260	0.01040	0.01210	0.0122	95	94	96	95
o-Xylenes	VOC	95-47-6	2.84849	7.51202	4.4508	3.0135	100	100	100	100
p-Dichlorobenzene	VOC	106-46-7	0.94395	0.62529	1.27463	0.7936	47	41	23	48
Propylene	VOC	115-07-1	4.0617	4.457597	9.85318	2.5472	100	100	100	100
Selenium	Metal	7782-49-2	0.00223	0.00224	0.00304	0.0024	90	88	96	90
Styrene	VOC	100-42-5	4.43015	3.02443	3.71451	4.3024	93	90	95	93
Tetrachloroethylene	VOC	127-18-4	0.83426	0.80034	2.72320	0.7393	48	69	48	53
Toluene	VOC	108-88-3	27.43479	105.14158	31.80627	15.5263	100	100	100	100
Total Chromium	Metal	7440-47-3	0.01780	0.02610	0.0166	0.0304	29	27	21	26
Trichloroethylene	VOC	79-01-6	0.24719	0.27944	-[2]	-	10	13	-	-

[1]HEAL = Hudson K-8 School site; LEAL = Lewis Elementary School site; RSAL = Riggins School site; and SLOSS = Shuttlesworth Station site
[2] Not detected

Table 3.1-1 Statistical Summary of Concentrations for the Hudson K-8 School Air Monitor (µg/m^3)[1]

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
1,2-Dichloroethane	60	0.01820	0.22700	0.07370	0.07890	0.04110	0.09680	NDD[2]
1,3-Butadiene	60	0.02650	0.64200	0.13900	0.08850	0.14100	0.16700	Lognormal
Acetonitrile	60	0.06130	3.59300	0.37600	0.28100	0.55300	0.68800	NDD
Arsenic	63	0.00026	0.00400	0.00151	0.00121	0.00092	0.00177	Lognormal
Benzene	60	0.36100	21.88000	3.44200	1.36600	5.30800	6.42900	NDD
Benzo(a)anthracene	68	0.00003	0.01610	0.00210	0.00063	0.00325	0.00576	Lognormal
Benzo(a)pyrene	68	0.00003	0.00955	0.00108	0.00030	0.00178	0.00202	NDD
Benzo(b)fluoranthene	68	0.00006	0.01930	0.00280	0.00100	0.00404	0.00493	NDD
Benzo(k)fluoranthene	68	0.00002	0.00545	0.00081	0.00027	0.00119	0.00144	NDD
Beryllium	63	0.00001	0.00008	0.00002	0.00001	0.00001	0.00002	NDD
Bromomethane	60	0.01750	0.14800	0.04930	0.05050	0.02610	0.06400	NDD
Cadmium	63	0.00008	0.00779	0.00089	0.00026	0.00155	0.00174	NDD
Carbon Disulfide	60	0.02180	0.27100	0.05950	0.05140	0.04260	0.08350	NDD
Carbon Tetrachloride	60	0.52200	0.90000	0.70000	0.69800	0.09460	0.72000	Lognormal
Chloroform	60	0.02200	0.28800	0.11800	0.11700	0.07170	0.15800	NDD
Chloromethane	60	0.94400	1.76100	1.22300	1.22900	0.16200	1.25800	Lognormal
Chrysene	68	0.00013	0.01660	0.00289	0.00115	0.00386	0.00493	NDD
Cobalt	63	0.00005	0.00122	0.00024	0.00020	0.00021	0.00028	Gamma
Dibenz(a,h)anthracene	68	0.00002	0.00225	0.00027	0.00008	0.00043	0.00049	NDD
Dichloromethane	60	0.28100	4.82800	0.77200	0.50900	0.72600	1.18000	NDD
Ethylbenzene	60	0.10900	1.81100	0.51100	0.41500	0.37500	0.59500	Lognormal
Hexavalent Chromium	63	0.00004	0.00018	0.00011	0.00012	0.00004	0.00012	Lognormal
Indeno(1,2,3-cd)pyrene	68	0.00003	0.00712	0.00096	0.00032	0.00147	0.00173	NDD
m,p-Xylene	60	0.26100	6.90400	1.49100	1.06600	1.33200	1.77900	Lognormal
Manganese	63	0.00229	0.11700	0.03090	0.02170	0.02700	0.03720	Gamma

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
Mercury	63	0.00001	0.00028	0.00003	0.00003	0.00004	0.00006	NDD
Methyl Isobutyl Ketone	60	0.04510	0.51600	0.19600	0.16200	0.12300	0.22400	Gamma
Naphthalene	68	0.03750	2.02000	0.48400	0.30900	0.47200	0.58700	Gamma
Nickel	63	0.00055	0.01260	0.00226	0.00200	0.00176	0.00258	Gamma
o-Xylene	60	0.10900	2.84800	0.62600	0.45400	0.52500	0.73900	Lognormal
p-Dichlorobenzene	60	0.05710	0.94400	0.19000	0.10500	0.18600	0.29500	NDD
Propylene	60	0.24600	4.06200	0.95300	0.69200	0.76600	1.08800	Lognormal
Selenium	63	0.00003	0.00223	0.00081	0.00080	0.00047	0.00091	Lognormal
Styrene	60	0.04690	4.43000	0.59400	0.22800	0.90000	1.10000	NDD
Tetrachloroethylene	60	0.06100	0.83400	0.15700	0.06780	0.14400	0.23800	NDD
Toluene	60	0.52800	27.43000	3.24400	1.85400	4.37100	3.77900	Lognormal
Trichloroethylene	60	0.05910	0.24700	0.07340	0.05910	0.03690	0.08140	Lognormal

[1]All statistical parameters were determined using ProUCL vers. 4.1. Software. Samples with non-detects or detected a concentrations lower that their respective detection limits were assigned 1/2 the detection limit before the ProUCL analysis. Therefore, the minimum concentration value for some chemicals in this table may be the 1/2 detection limit.

[2] NDD = No discernable distribution. Data do not fit a given distribution at 5% significant level. In this case, ProUCL uses non-parametric approaches to calculate the 95UCL value.

Table 3.1-2 Statistical Summary of Concentrations for the Lewis Elementary School Air Monitor (µg/m^3)[1]

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
1,2-Dichloroethane	61	0.01820	0.15000	0.08180	0.09310	0.03950	0.10400	NDD[2]
1,3-Butadiene	61	0.00774	0.60600	0.15200	0.10800	0.14000	0.19400	Lognormal
Acetonitrile	61	0.06130	1.44600	0.31000	0.29900	0.23900	0.44300	NDD
Arsenic	66	0.00017	0.00465	0.00146	0.00106	0.00108	0.00178	Lognormal
Benzene	61	0.37400	20.45000	2.89000	1.01900	3.89500	5.06400	NDD
Benzo(a)anthracene	62	0.00002	0.03010	0.00270	0.00037	0.00587	0.00594	NDD
Benzo(a)pyrene	62	0.00003	0.01530	0.00145	0.00016	0.00316	0.00320	NDD
Benzo(b)fluoranthene	62	0.00003	0.03190	0.00331	0.00048	0.00654	0.00694	NDD
Benzo(k)fluoranthene	62	0.00002	0.01060	0.00104	0.00015	0.00214	0.00222	NDD
Beryllium	66	0.00001	0.00008	0.00002	0.00001	0.00001	0.00003	NDD
Bromomethane	61	0.01750	0.10100	0.04850	0.05050	0.02230	0.06090	NDD
Cadmium	66	0.00004	0.00668	0.00072	0.00033	0.00105	0.00092	Lognormal
Carbon Disulfide	61	0.02180	0.19900	0.05920	0.05140	0.04050	0.08180	NDD
Carbon Tetrachloride	61	0.30800	0.98800	0.71500	0.72400	0.11500	0.73900	Lognormal
Chloroform	61	0.02200	0.30300	0.11200	0.11700	0.07240	0.15300	NDD
Chloromethane	61	0.96000	1.86700	1.26400	1.21200	0.23500	1.31300	Gamma
Chrysene	62	0.00011	0.03150	0.00346	0.00069	0.00650	0.00705	NDD
Cobalt	66	0.00004	0.00056	0.00020	0.00017	0.00013	0.00022	Gamma
Dibenz(a,h)anthracene	62	0.00002	0.00349	0.00033	0.00003	0.00071	0.00073	NDD
Dichloromethane	61	0.25400	3.34200	0.74300	0.63900	0.49100	0.83700	Gamma
Ethylbenzene	61	0.10900	4.47200	0.86200	0.49900	0.85500	1.08000	Lognormal
Hexavalent Chromium	66	0.00004	0.00026	0.00011	0.00012	0.00004	0.00012	Lognormal
Indeno(1,2,3-cd)pyrene	62	0.00003	0.00987	0.00111	0.00017	0.00217	0.00230	Lognormal
m,p-Xylene	61	0.24300	19.67000	2.92100	1.45900	3.54700	3.87700	Lognormal
Manganese	66	0.00256	0.16500	0.03420	0.02120	0.03240	0.04610	Lognormal
Mercury	66	0.00001	0.00009	0.00003	0.00003	0.00001	0.00003	Lognormal
Methyl Isobutyl Ketone	61	0.03070	0.98300	0.27000	0.24600	0.19500	0.31900	Gamma

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
Naphthalene	62	0.02030	1.83000	0.45600	0.27000	0.48800	0.65800	Lognormal
Nickel	66	0.00055	0.01040	0.00257	0.00209	0.00190	0.00296	Gamma
o-Xylene	61	0.09990	7.51200	1.10300	0.61700	1.27600	1.81500	NDD
p-Dichlorobenzene	61	0.05710	0.62500	0.15600	0.10500	0.12200	0.22400	NDD
Propylene	61	0.31300	4.45800	1.21800	0.87300	0.92700	1.42500	Lognormal
Selenium	66	0.00003	0.00224	0.00071	0.00070	0.00043	0.00080	Lognormal
Styrene	61	0.04690	3.02400	0.45500	0.23400	0.58000	0.77900	NDD
Tetrachloroethylene	61	0.06100	0.80000	0.22200	0.17600	0.17000	0.31700	NDD
Toluene	61	0.48200	105.10000	4.41700	1.92200	13.29000	4.27300	Lognormal
Trichloroethylene	61	0.05910	0.27900	0.07860	0.05910	0.04730	0.08870	Lognormal

[1]All statistical parameters were determined using ProUCL vers. 4.1. Software. Samples with non-detects or detected a concentrations lower that their respective detection limits were assigned 1/2 the detection limit before the ProUCL analysis. Therefore, the minimum concentration value for some chemicals in this table may be the 1/2 detection limit.

[2] NDD = No discernable distribution. Data do not fit a given distribution at 5% significant level. In this case, ProUCL uses non-parametric approaches to calculate the 95UCL value.

Table 3.1-3 Statistical Summary of Concentrations for the Riggins School Air Monitor (µg/m³)[1]

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
1,2-Dichloroethane	65	0.01820	0.13700	0.07480	0.08900	0.03790	0.09530	NDD[2]
1,3-Butadiene	65	0.00774	0.92000	0.16700	0.11000	0.17600	0.20300	Gamma
Acetonitrile	65	0.06130	9.04200	0.56100	0.28300	1.52200	1.38400	NDD
Arsenic	67	0.00008	0.01080	0.00230	0.00170	0.00207	0.00274	Gamma
Benzene	65	0.35100	55.11000	6.09700	2.76800	9.25800	8.59500	Lognormal
Benzo(a)anthracene	71	0.00006	0.03850	0.00692	0.00315	0.00898	0.00922	Gamma
Benzo(a)pyrene	71	0.00003	0.02150	0.00347	0.00161	0.00506	0.00478	Gamma
Benzo(b)fluoranthene	71	0.00010	0.04710	0.00828	0.00388	0.01070	0.01100	Gamma
Benzo(k)fluoranthene	71	0.00002	0.01320	0.00250	0.00118	0.00328	0.00334	Gamma
Beryllium	67	0.00001	0.00008	0.00002	0.00002	0.00002	0.00003	NDD
Bromomethane	65	0.01750	0.44700	0.05780	0.05240	0.05630	0.08820	NDD
Cadmium	67	0.00005	0.00274	0.00048	0.00032	0.00054	0.00057	Lognormal
Carbon Disulfide	65	0.02180	0.46900	0.09480	0.05450	0.08710	0.14200	NDD
Carbon Tetrachloride	65	0.53000	0.96600	0.69300	0.68700	0.09370	0.71300	Lognormal
Chloroform	65	0.02200	0.25400	0.11200	0.11600	0.05470	0.14200	NDD
Chloromethane	65	0.92600	20.64000	1.55900	1.18700	2.42300	2.06100	Lognormal
Chrysene	71	0.00017	0.04620	0.00882	0.00436	0.01070	0.01140	Gamma
Cobalt	67	0.00004	0.00067	0.00020	0.00017	0.00014	0.00023	Gamma
Dibenz(a,h)anthracene	71	0.00002	0.00469	0.00081	0.00036	0.00114	0.00140	NDD
Dichloromethane	65	0.21100	5.47600	0.83500	0.55400	0.79100	1.26200	NDD
Ethylbenzene	65	0.10500	3.60200	0.45800	0.33900	0.48200	0.51000	Lognormal
Hexavalent Chromium	67	0.00004	0.00017	0.00011	0.00012	0.00004	0.00012	Lognormal
Indeno(1,2,3-cd)pyrene	71	0.00003	0.01570	0.00277	0.00123	0.00383	0.00374	Gamma
m,p-Xylene	65	0.25100	7.18600	1.32900	0.94700	1.30300	1.56400	Gamma
Manganese	67	0.00247	0.05760	0.01670	0.01390	0.01250	0.01950	Gamma
Mercury	67	0.00001	0.00053	0.00004	0.00003	0.00007	0.00008	NDD

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
Methyl Isobutyl Ketone	65	0.03070	0.43000	0.15500	0.12300	0.09240	0.17600	Gamma
Naphthalene	71	0.03430	5.73500	0.87200	0.58000	0.97100	1.08100	Gamma
Nickel	67	0.00053	0.01210	0.00264	0.00234	0.00175	0.00299	Gamma
o-Xylene	65	0.09660	4.45100	0.57000	0.40200	0.64300	0.65200	Lognormal
p-Dichlorobenzene	65	0.05710	1.27500	0.11800	0.10500	0.15200	0.20000	NDD
Propylene	65	0.21500	9.85300	1.23100	0.92700	1.31900	1.39900	Lognormal
Selenium	67	0.00003	0.00304	0.00099	0.00087	0.00064	0.00112	Lognormal
Styrene	65	0.04690	3.71500	0.62100	0.33900	0.70800	0.82000	Lognormal
Tetrachloroethylene	65	0.06100	2.72300	0.17100	0.06780	0.33400	0.35200	NDD
Toluene	65	0.55200	31.81000	3.07300	2.10700	4.40700	3.54500	Lognormal

[1]All statistical parameters were determined using ProUCL vers. 4.1. Software. Samples with non-detects or detected a concentrations lower that their respective detection limits were assigned 1/2 the detection limit before the ProUCL analysis. Therefore, the minimum concentration value for some chemicals in this table may be the 1/2 detection limit.

[2] NDD = No discernable distribution. Data do not fit a given distribution at 5% significant level. In this case, ProUCL uses non-parametric approaches to calculate the 95UCL value.

Table 3.1-4 Statistical Summary of Concentrations for the Shuttlesworth Station Air Monitor (µg/m^3)[1]

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
1,2-Dichloroethane	60	0.01820	0.86200	0.09790	0.09710	0.10700	0.15800	NDD[2]
1,3-Butadiene	60	0.03100	0.49300	0.14900	0.11800	0.10900	0.17400	Gamma
Acetonitrile	60	0.06130	0.60600	0.26200	0.26900	0.12700	0.28900	Lognormal
Arsenic	62	0.00008	0.00745	0.00236	0.00211	0.00163	0.00270	Lognormal
Benzene	60	0.52100	22.72000	4.13400	2.51600	4.83700	5.12500	Gamma
Benzo(a)anthracene	68	0.00006	0.01370	0.00333	0.00235	0.00329	0.00422	Gamma
Benzo(a)pyrene	68	0.00003	0.00753	0.00157	0.00102	0.00171	0.00203	Gamma
Benzo(b)fluoranthene	68	0.00010	0.01530	0.00405	0.00321	0.00373	0.00506	Gamma
Benzo(k)fluoranthene	68	0.00002	0.00438	0.00121	0.00088	0.00115	0.00153	Gamma
Beryllium	62	0.00001	0.00009	0.00002	0.00002	0.00002	0.00003	NDD
Bromomethane	60	0.01750	0.10100	0.04950	0.05050	0.02200	0.06190	NDD
Cadmium	62	0.00002	0.00246	0.00042	0.00024	0.00044	0.00067	NDD
Carbon Disulfide	59	0.02180	0.18400	0.06730	0.05140	0.03780	0.08870	NDD
Carbon Tetrachloride	60	0.47200	0.93700	0.71400	0.73600	0.10400	0.73600	Lognormal
Chloroform	60	0.02200	0.80600	0.13400	0.12500	0.11400	0.19800	NDD
Chloromethane	60	0.92500	1.75900	1.20800	1.15900	0.18300	1.24700	Gamma
Hexavalent Chromium	62	0.00406	0.03040	0.01170	0.01210	0.00494	0.01280	Lognormal
Chrysene	68	0.00026	0.01630	0.00452	0.00374	0.00398	0.00554	Gamma
Cobalt	62	0.00001	0.00059	0.00021	0.00019	0.00013	0.00024	Lognormal
Dibenz (a,h) anthracene	68	0.00002	0.00176	0.00039	0.00026	0.00040	0.00060	NDD
Dichloromethane	60	0.26400	23.17000	1.04000	0.55800	2.93100	2.68900	NDD
Ethylbenzene	60	0.09990	1.84500	0.49500	0.36700	0.35500	0.58300	Lognormal
Hexavalent Chromium	62	0.00004	0.00030	0.00012	0.00012	0.00005	0.00013	NDD
Indeno(1,2,3-cd)pyrene	68	0.00003	0.00498	0.00135	0.00097	0.00131	0.00171	Gamma
m,p-Xylene	60	0.22600	7.42500	1.44600	1.01400	1.29700	1.70900	Gamma
Manganese	62	0.00050	0.06070	0.02280	0.02240	0.01430	0.02590	Lognormal
Mercury	62	0.00001	0.00014	0.00003	0.00003	0.00002	0.00004	NDD

Chemical	Number of Valid Samples	Min	Max	Mean	Median	Standard Deviation	95UCL	Type of Distribution
Methyl Isobutyl Ketone	60	0.03070	0.68000	0.17500	0.15000	0.12500	0.20500	Gamma
Naphthalene	68	0.04650	2.06000	0.69500	0.49900	0.52600	0.82500	Gamma
Nickel	62	0.00057	0.01220	0.00287	0.00197	0.00223	0.00344	Lognormal
o-Xylene	60	0.09550	3.01300	0.60100	0.44300	0.51500	0.70400	Gamma
p-Dichlorobenzene	60	0.05710	0.79400	0.18600	0.10500	0.16300	0.27800	NDD
Propylene	60	0.34400	2.54700	1.01200	0.83100	0.59900	1.14700	Gamma
Selenium	62	0.00003	0.00236	0.00085	0.00081	0.00051	0.00096	Lognormal
Styrene	60	0.04690	4.30200	0.71700	0.30500	0.97000	0.99900	Lognormal
Tetrachloroethylene	60	0.06100	0.73900	0.16600	0.13600	0.14100	0.24600	NDD
Toluene	60	0.52800	15.53000	2.89000	1.99400	2.54600	3.41100	Gamma

[1]All statistical parameters were determined using ProUCL vers. 4.1. Software. Samples with non-detects or detected a concentrations lower that their respective detection limits were assigned 1/2 the detection limit before the ProUCL analysis. Therefore, the minimum concentration value for some chemicals in this table may be the 1/2 detection limit.

[2] NDD = No discernable distribution. Data do not fit a given distribution at 5% significant level. In this case, ProUCL uses non-parametric approaches to calculate the 95UCL value.

Table 5.1.1-1 Cancer Risks for the Hudson K-8 School Site Chemicals of Potential Concern

Chemical	CAS #	Median Conc. (µg/m^3)	95UCL Conc. (µg/m^3)	IUR (1/µg/m^3)	EPA WOE	Source	IARC WOE	95UCL Risk	% Risk	Cumulative % Risk
Benzene	71-43-2	1.366	6.429	7.8E-06	CH	IRIS	1	5.E-05	47.27%	47.27%
Naphthalene	91-20-3	0.309	0.587	3.4E-05	C	CAL		2.E-05	18.81%	66.08%
Arsenic	7440-38-2	0.00121	0.00177	4.3E-03	A	IRIS	1	8.E-06	7.17%	73.26%
1,3-Butadiene	106-99-0	0.0885	0.167	3.0E-05	CH	IRIS	1	5.E-06	4.72%	77.98%
Carbon Tetrachloride	56-23-5	0.698	0.72	6.0E-06	LH	IRIS	2B	4.E-06	4.07%	82.05%
Benzo (a) pyrene[1]	50-32-8	0.000302	0.00202	1.8.E-03	B2	CAL	1	4.E-06	3.47%	85.52%
p-Dichlorobenzene	106-46-7	0.105	0.295	1.1E-05	C	CAL	2B	3.E-06	3.06%	88.58%
Cadmium	7440-43-9	0.00026	0.00174	1.8E-03	B1	IRIS	1	3.E-06	2.95%	91.54%
1,2-Dichloroethane	107-06-2	0.0789	0.0968	2.6E-05	B2	IRIS	2B	3.E-06	2.37%	93.91%
Ethylbenzene	100-41-4	0.415	0.595	2.5E-06	D	CAL	2B	1.E-06	1.40%	95.31%
Hexavalent Chromium[2]	7440-47-3	0.0121	0.0122	1.2E-04	CH	IRIS	1	1.E-06	1.38%	96.69%
Benzo (a) anthracene[1]	56-55-3	0.0006335	0.00576	1.8E-04	B2	CAL	2B	1.E-06	0.99%	97.68%
Dibenz (a,h) anthracene[1]	53-70-3	0.00007945	0.00049492	2.0E-03	B2	CAL	2A	1.E-06	0.93%	98.61%
Benzo (b) fluoranthene	205-99-2	0.001	0.00493	1.1E-04	B2	CAL	2B	5.E-07	0.51%	99.12%
Trichloroethylene[1]	79-01-6	0.0591	0.0814	4.8.E-06	CH	IRIS	2A	4.E-07	0.37%	99.49%
Indeno(1,2,3-cd)pyrene	193-39-5	0.000316	0.00173	1.1E-04	B2	CAL	2B	2.E-07	0.18%	99.67%
Benzo (k) fluoranthene	207-08-9	0.0002725	0.00144	1.1E-04	B2	CAL	2B	2.E-07	0.15%	99.82%
Tetrachloroethylene	127-18-4	0.0678	0.238	2.6E-07	LH	IRIS	2A	6.E-08	0.06%	99.87%
Beryllium	7440-41-7	0.00001	0.000024525	2.4E-03	LH	IRIS	1	6.E-08	0.06%	99.93%
Chrysene	218-01-9	0.00115	0.00493	1.1E-05	B2	CAL	2B	5.E-08	0.05%	99.98%
Dichloromethane[1]	75-09-2	0.509	1.18	1.7.E-08	LH	IRIS	2B	2.E-08	0.02%	100.00%
						Total		1.E-04		

[1]Chemicals that are carcinogenic by a mutagenic mode of action and for which data on early life susceptibility are not available. The IURs for these chemicals, except trichloroethylene, were adjusted for to include ages younger than 16 years using age-specific default adjustment factors (See Section 5.1.1). For trichloroethylene, we used a recently IRIS-published adjusted IUR (EPA, 2011).

[2]Estimated from total chromium; See Section 4.3.

Table 5.1.1-2 Cancer Risks for the Lewis Elementary School Site Chemicals of Potential Concern

Chemical	CAS #	Median Conc. (µg/m^3)	95UCL Conc. (µg/m^3)	IUR (1/µg/m^3)	EPA WOE	Source	IARC WOE	95UCL Risk	% Risk	Cumulative % Risk
Benzene	71-43-2	1.019	5.064	7.8.E-06	CH	IRIS	1	4.E-05	39.09%	39.09%
Naphthalene	91-20-3	0.27	0.658	3.4.E-05	C	CAL		2.E-05	22.14%	61.23%
Arsenic	7440-38-2	0.00106	0.00178	4.3.E-03	A	IRIS	1	8.E-06	7.57%	68.81%
Benzo (a) pyrene[1]	50-32-8	0.0001615	0.0032	1.8.E-03	B2	CAL	1	6.E-06	5.77%	74.58%
1,3-Butadiene	106-99-0	0.108	0.194	3.0.E-05	CH	IRIS	1	6.E-06	5.76%	80.34%
Carbon Tetrachloride	56-23-5	0.724	0.739	6.0.E-06	LH	IRIS	2B	4.E-06	4.39%	84.73%
1,2-Dichloroethane	107-06-2	0.0931	0.104	2.6.E-05	B2	IRIS	2B	3.E-06	2.68%	87.40%
Ethylbenzene	100-41-4	0.499	1.08	2.5.E-06	D	CAL	2B	3.E-06	2.67%	90.08%
p-Dichlorobenzene	106-46-7	0.105	0.224	1.1.E-05	C	CAL	2B	2.E-06	2.44%	92.51%
Cadmium	7440-43-9	0.00033	0.00092137	1.8.E-03	B1	IRIS	1	2.E-06	1.64%	94.16%
Hexavalent Chromium[2]	7440-47-3	0.0121	0.0121	1.2.E-04	CH	IRIS	1	1.E-06	1.44%	95.59%
Dibenz (a,h) anthracene[1]	53-70-3	0.000034825	0.00072914	2.0.E-03	B2	CAL	2A	1.E-06	1.43%	97.03%
Benzo (a) anthracene[1]	56-55-3	0.000372	0.00594	1.8.E-04	B2	CAL	2B	1.E-06	1.07%	98.10%
Benzo (b) fluoranthene	205-99-2	0.000477	0.00694	1.1.E-04	B2	CAL	2B	8.E-07	0.76%	98.85%
Trichloroethylene[1]	79-01-6	0.0591	0.0887	4.8.E-06	CH	IRIS	2A	4.E-07	0.42%	99.28%
Indeno(1,2,3-cd)pyrene	193-39-5	0.000165	0.0023	1.1.E-04	B2	CAL	2B	3.E-07	0.25%	99.53%
Benzo (k) fluoranthene	207-08-9	0.0001515	0.00222	1.1.E-04	B2	CAL	2B	2.E-07	0.24%	99.77%
Tetrachloroethylene	127-18-4	0.176	0.317	2.6.E-07	LH	IRIS	2A	8.E-08	0.08%	99.85%
Chrysene	218-01-9	0.000693	0.00705	1.1.E-05	B2	CAL	2B	8.E-08	0.08%	99.93%
Beryllium	7440-41-7	0.00001	0.000025216	2.4.E-03	LH	IRIS	1	6.E-08	0.06%	99.99%
Dichloromethane[1]	75-09-2	0.639	0.837	1.7.E-08	LH	IRIS	2B	1.E-08	0.01%	100.00%
						Total		1.E-04		

[1]Chemicals that are carcinogenic by a mutagenic mode of action and for which data on early life susceptibility are not available. The IURs for these chemicals, except trichloroethylene, were adjusted for to include ages younger than 16 years using age-specific default adjustment factors (See Section 5.1.1). For trichloroethylene, we used a recently IRIS-published adjusted IUR (EPA, 2011).

[2]Estimated from total chromium; See Section 4.3.

Table 5.1.1-3 Cancer Risks for the Riggins School Site Chemicals of Potential Concern

Chemical	CAS #	Median Conc. (µg/m^3)	95UCL Conc. (µg/m^3)	IUR (1/µg/m^3)	EPA WOE	Source	IARC WOE	95UCL Risk	% Risk	Cumulative % Risk
Benzene	71-43-2	2.768	8.595	7.8.E-06	CH	IRIS	1	7.E-05	44.76%	44.76%
Naphthalene	91-20-3	0.58	1.081	3.4.E-05	C	CAL		4.E-05	24.54%	69.30%
Arsenic	7440-38-2	0.0017	0.00274	4.3.E-03	A	IRIS	1	1.E-05	7.87%	77.16%
Benzo (a) pyrene[1]	50-32-8	0.00161	0.00478	1.8.E-03	B2	CAL	1	9.E-06	5.82%	82.98%
1,3-Butadiene	106-99-0	0.11	0.203	3.0.E-05	CH	IRIS	1	6.E-06	4.07%	87.05%
Carbon Tetrachloride	56-23-5	0.687	0.713	6.0.E-06	LH	IRIS	2B	4.E-06	2.86%	89.90%
Dibenz (a,h) anthracene[1]	53-70-3	0.00036	0.0014	2.0.E-03	B2	CAL	2A	3.E-06	1.86%	91.76%
1,2-Dichloroethane	107-06-2	0.089	0.0953	2.6.E-05	B2	IRIS	2B	2.E-06	1.65%	93.41%
p-Dichlorobenzene	106-46-7	0.105	0.2	1.1.E-05	C	CAL	2B	2.E-06	1.47%	94.88%
Benzo (a) anthracene[1]	56-55-3	0.00315	0.00922	1.8.E-04	B2	CAL	2B	2.E-06	1.12%	96.01%
Hexavalent Chromium[2]	7440-47-3	0.0121	0.0115	1.2.E-04	CH	IRIS	1	1.E-06	0.92%	96.93%
Ethylbenzene	100-41-4	0.339	0.51000	2.5.E-06	D	CAL	2B	1.E-06	0.85%	97.78%
Benzo (b) fluoranthene	205-99-2	0.00388	0.011	1.1.E-04	B2	CAL	2B	1.E-06	0.81%	98.59%
Cadmium	7440-43-9	0.00032	0.00056533	1.8.E-03	B1	IRIS	1	1.E-06	0.68%	99.27%
Indeno(1,2,3-cd)pyrene	193-39-5	0.00123	0.00374	1.1.E-04	B2	CAL	2B	4.E-07	0.27%	99.54%
Benzo (k) fluoranthene	207-08-9	0.00118	0.00334	1.1.E-04	B2	CAL	2B	4.E-07	0.25%	99.79%
Chrysene	218-01-9	0.00436	0.0114	1.1.E-05	B2	CAL	2B	1.E-07	0.08%	99.87%
Tetrachloroethylene	127-18-4	0.06780	0.352000	2.6.E-07	LH	IRIS	2A	9.E-08	0.06%	99.93%
Beryllium	7440-41-7	0.000015	0.000032505	2.4.E-03	LH	IRIS	1	8.E-08	0.05%	99.98%
Dichloromethane[1]	75-09-2	0.554	1.262	2.1.E-08	LH	IRIS	2B	3.E-08	0.02%	100.00%
						Total		1.E-04		

[1]Chemicals that are carcinogenic by a mutagenic mode of action and for which data on early life susceptibility are not available. The IURs for these chemicals, except trichloroethylene, were adjusted for to include ages younger than 16 years using age-specific default adjustment factors (See Section 5.1.1). For trichloroethylene, we used a recently IRIS-published adjusted IUR (EPA, 2011).

[2]Estimated from total chromium; See Section 4.3.

Table 5.1.1-4 Cancer Risks for the Shuttlesworth Station Site Chemicals of Potential Concern

Chemical	CAS #	Median Conc. (µg/m^3)	95UCL Conc. (µg/m^3)	IUR (1/µg/m^3)	EPA WOE	Source	IARC WOE	95UCL Risk	% Risk	Cumulative % Risk
Benzene	71-43-2	2.516	5.125	7.8.E-06	CH	IRIS	1	4.E-05	37.20%	37.20%
Naphthalene	91-20-3	0.499	0.825	3.4.E-05	C	CAL		3.E-05	26.10%	63.31%
Arsenic	7440-38-2	0.00211	0.0027	4.3.E-03	A	IRIS	1	1.E-05	10.80%	74.11%
1,3-Butadiene	106-99-0	0.118	0.174	3.0.E-05	CH	IRIS	1	5.E-06	4.86%	78.97%
Carbon Tetrachloride	56-23-5	0.736	0.736	6.0.E-06	LH	IRIS	2B	4.E-06	4.11%	83.08%
1,2-Dichloroethane	107-06-2	0.0971	0.158	2.6.E-05	B2	IRIS	2B	4.E-06	3.82%	86.90%
Benzo (a) pyrene[1]	50-32-8	0.00102	0.00203	1.8.E-03	B2	CAL	1	4.E-06	3.44%	90.35%
p-Dichlorobenzene	106-46-7	0.105	0.278	1.1.E-05	C	CAL	2B	3.E-06	2.85%	93.19%
Hexavalent Chromium[2]	7440-47-3	0.0121	0.0128	1.2.E-04	CH	IRIS		2.E-06	1.43%	94.62%
Ethylbenzene	100-41-4	0.367	0.583	2.5.E-06	D	CAL	2B	1.E-06	1.36%	95.98%
Cadmium	7440-43-9	0.00024	0.0006656	1.8.E-03	B1	IRIS	1	1.E-06	1.11%	97.09%
Dibenz (a,h) anthracene[1]	53-70-3	0.0002585	0.0005993	2.0.E-03	B2	CAL	2A	1.E-06	1.11%	98.20%
Benzo (a) anthracene[1]	56-55-3	0.00235	0.00422	1.8.E-04	B2	CAL	2B	8.E-07	0.72%	98.92%
Benzo (b) fluoranthene	205-99-2	0.00321	0.00506	1.1.E-04	B2	CAL	2B	6.E-07	0.52%	99.44%
Indeno(1,2,3-cd)pyrene	193-39-5	0.00097	0.00171	1.1.E-04	B2	CAL	2B	2.E-07	0.18%	99.61%
Benzo (k) fluoranthene	207-08-9	0.000882	0.00153	1.1.E-04	B2	CAL	2B	2.E-07	0.16%	99.77%
Beryllium	7440-41-7	0.00002	3.272E-05	2.4.E-03	LH	IRIS	1	8.E-08	0.07%	99.84%
Tetrachloroethylene	127-18-4	0.136	0.246	2.6.E-07	LH	IRIS	2A	6.E-08	0.06%	99.90%
Chrysene	218-01-9	0.00374	0.00554	1.1.E-05	B2	CAL	2B	6.E-08	0.06%	99.96%
Dichloromethane[1]	75-09-2	0.558	2.689	1.7.E-08	LH	IRIS	2B	4.E-08	0.04%	100.00%
						Total		1.E-04		

[1]Chemicals that are carcinogenic by a mutagenic mode of action and for which data on early life susceptibility are not available. The IURs for these chemicals, except trichloroethylene, were adjusted for to include ages younger than 16 years using age-specific default adjustment factors (See Section 5.1.1). For trichloroethylene, we used a recently IRIS-published adjusted IUR (EPA, 2011).

[2]Estimated from total chromium; See Section 4.3.

Table 5.1.2-1 Non-cancer Hazard Quotients for the Hudson K-8 School Chemicals of Potential Concern

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Manganese	7439-96-5	0.0372	0.05	IRIS	Neurological	0.7	44%
Benzene	71-43-2	6.429	30	IRIS	Immunological	0.2	13%
Naphthalene	91-20-3	0.587	3	IRIS	Respiratory	0.2	12%
Cadmium	7440-43-9	0.00174	0.01	D-ATSDR	Kidney/Respiratory	0.2	10%
Arsenic	7440-38-2	0.00177	0.015	CAL	Developmental	0.1	7%
1,3-Butadiene	106-99-0	0.167	2	IRIS	Reproductive	0.1	5%
Trichloroethylene	79-01-6	0.0814	2	IRIS	Neurological/Ocular	0.04	2%
Nickel	7440-02-0	0.00258	0.09	ATSDR	Respiratory	0.03	2%
m,p-Xylene[1]	108-38-3, 106-42-3	1.779	100	IRIS	Neurological	0.02	1%
Chloromethane	74-87-3	1.258	90	IRIS	Neurological	0.01	1%
Bromomethane	74-83-9	0.064	5	IRIS	Respiratory	0.01	0.8%
Acetonitrile	75-05-8	0.688	60	IRIS	Death	0.01	0.7%
o-Xylene[1]	95-47-6	0.739	100	IRIS	Neurological	0.01	0.4%
Carbon Tetrachloride	56-23-5	0.72	100	IRIS	Liver	0.01	0.4%
Tetrachloroethylene	127-18-4	0.238	40	IRIS	Neurological	0.01	0.4%
Cobalt	7440-48-4	0.000280	0.1	ATSDR	Respiratory	0.003	0.2%
Dichloromethane	75-09-2	1.18	600	IRIS	Liver	0.002	0.1%
Chloroform	67-66-3	0.158	98	ATSDR	Liver	0.002	0.1%
Beryllium	7440-41-7	0.000025	0.02	IRIS	Respiratory	0.001	0.07%
Hexavalent Chromium	18540-29-9	0.000122	0.1	IRIS	Anemia/damage to Gastrointerstinal	0.001	0.07%
Styrene	100-42-5	1.1	1000	IRIS	Neurological	0.001	0.07%
Toluene	108-88-3	3.779	5000	IRIS	Neurological/Respiratory	0.001	0.04%
Ethylbenzene	100-41-4	0.595	1000	IRIS	Developmental	0.001	0.04%
p-Dichlorobenzene	106-46-7	0.295	800	IRIS	Liver	0.0004	0.02%
Propylene	115-07-1	1.088	3000	CAL	Neurological	0.0004	0.02%

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Mercury	7439-97-6	0.000057	0.3	IRIS	Neurological	0.0002	0.01%
Carbon Disulfide	75-15-0	0.0835	700	IRIS	Neurological	0.0001	0.007%
Methyl Isobutyl Ketone	108-10-1	0.224	3000	IRIS	Developmental	0.0001	0.004%
Selenium	7782-49-2	0.00091	20	CAL	Skin/Neurological/Liver/Hematologic	0.00005	0.003%
1,2-Dichloroethane	107-06-2	0.0968	2400	ATSDR	Liver	0.00004	0.002%
					Hazard Index	**2**	

[1]Were assigned the RfC value of mixed Xylenes

Table 5.1.2-2 Non-cancer Hazard Quotients for the Lewis Elementary School Chemicals of Potential Concern

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Manganese	7439-96-5	0.0461	0.05	IRIS	Neurological	0.9	51%
Naphthalene	91-20-3	0.658	3	IRIS	Respiratory	0.2	12%
Benzene	71-43-2	5.064	30	IRIS	Immunological	0.2	9%
Arsenic	7440-38-2	0.00178	0.015	CAL	Developmental	0.1	7%
1,3-Butadiene	106-99-0	0.194	2	IRIS	Reproductive	0.1	5%
Cadmium	7440-43-9	0.000922	0.01	D-ATSDR	Kidney/Respiratory	0.1	5%
Trichloroethylene	79-01-6	0.0887	2	IRIS	Neurological/Ocular	0.04	2%
m,p-Xylene[1]	108-38-3, 106-42-3	3.877	100	IRIS	Neurological	0.04	2%
Nickel	7440-02-0	0.00296	0.09	ATSDR	Respiratory	0.03	2%
o-Xylene[1]	95-47-6	1.815	100	IRIS	Neurological	0.02	1%
Chloromethane	74-87-3	1.313	90	IRIS	Neurological	0.01	1%
Bromomethane	74-83-9	0.0609	5	IRIS	Respiratory	0.01	1%
Tetrachloroethylene	127-18-4	0.317	40	IRIS	Neurological	0.01	0.4%
Carbon Tetrachloride	56-23-5	0.739	100	IRIS	Liver	0.01	0.4%
Acetonitrile	75-05-8	0.443	60	IRIS	Death	0.01	0.4%
Cobalt	7440-48-4	0.000225	0.1	ATSDR	Respiratory	0.002	0.1%
Chloroform	67-66-3	0.153	98	ATSDR	Liver	0.002	0.1%
Dichloromethane	75-09-2	0.837	600	IRIS	Liver	0.001	0.1%
Beryllium	7440-41-7	0.000026	0.02	IRIS	Respiratory	0.001	0.1%
Hexavalent Chromium	18540-29-9	0.000121	0.1	IRIS	Anemia/damage to Gastrointerstinal	0.001	0.07%
Ethylbenzene	100-41-4	1.08	1000	IRIS	Developmental	0.001	0.06%
Toluene	108-88-3	4.273	5000	IRIS	Neurological/Respiratory	0.001	0.05%
Styrene	100-42-5	0.779	1000	IRIS	Neurological	0.001	0.04%
Propylene	115-07-1	1.425	3000	CAL	Neurological	0.0005	0.03%
p-Dichlorobenzene	106-46-7	0.224	800	IRIS	Liver	0.0003	0.02%
Carbon Disulfide	75-15-0	0.0818	700	IRIS	Neurological	0.0001	0.01%

Chemical	CAS #	95UCL Conc. ($\mu g/m^3$)	RfC ($\mu g/m^3$)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Methyl Isobutyl Ketone	108-10-1	0.319	3000	IRIS	Developmental	0.0001	0.006%
Mercury	7439-97-6	0.0000276	0.3	IRIS	Neurological	0.0001	0.005%
1,2-Dichloroethane	107-06-2	0.104	2400	ATSDR	Liver	0.00004	0.002%
Selenium	7782-49-2	0.000803	20	CAL	Skin/Neurological/Liver/ Hematologic	0.00004	0.002%
					Hazard Index	2	

[1]Were assigned the RfC value of mixed Xylenes

Table 5.1.2-3 Non-cancer Hazard Quotients for the Riggins School Chemicals of Potential Concern

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Manganese	7439-96-5	0.0195	0.05	IRIS	Neurological	0.4	26%
Naphthalene	91-20-3	1.081	3	IRIS	Respiratory	0.4	24%
Benzene	71-43-2	8.595	30	IRIS	Immunological	0.3	19%
Arsenic	7440-38-2	0.00274	0.015	CAL	Developmental	0.2	12%
1,3-Butadiene	106-99-0	0.203	2	IRIS	Reproductive	0.1	7%
Cadmium	7440-43-9	0.000565	0.01	D-ATSDR	Kidney/Respiratory	0.1	4%
Nickel	7440-02-0	0.00299	0.09	ATSDR	Respiratory	0.03	2%
Acetonitrile	75-05-8	1.384	60	IRIS	Death	0.02	2%
Chloromethane	74-87-3	2.061	90	IRIS	Neurological	0.02	2%
Bromomethane	74-83-9	0.0882	5	IRIS	Respiratory	0.02	1%
m,p-Xylene[1]	108-38-3, 106-42-3	1.564	100	IRIS	Neurological	0.02	1%
Tetrachloroethylene	127-18-4	0.352	40	IRIS	Neurological	0.01	1%
Carbon Tetrachloride	56-23-5	0.713	100	IRIS	Liver	0.01	0.5%
o-Xylene[1]	95-47-6	1.815	100	IRIS	Neurological	0.007	0.4%
Cobalt	7440-48-4	0.000233	0.1	ATSDR	Respiratory	0.002	0.2%
Dichloromethane	75-09-2	1.262	600	IRIS	Liver	0.002	0.1%
Beryllium	7440-41-7	0.000033	0.02	IRIS	Respiratory	0.002	0.1%
Chloroform	67-66-3	0.142	98	ATSDR	Liver	0.001	0.1%
Hexavalent Chromium	18540-29-9	0.000116	0.1	IRIS	Anemia/damage to Gastrointerstinal	0.001	0.08%
Styrene	100-42-5	0.82	1000	IRIS	Neurological	0.001	0.1%
Toluene	108-88-3	3.545	5000	IRIS	Neurological/Respiratory	0.001	0.05%
Ethylbenzene	100-41-4	0.51	1000	IRIS	Developmental	0.001	0.03%
Propylene	115-07-1	1.399	3000	CAL	Neurological	0.0005	0.0%
Mercury	7439-97-6	0.00008	0.3	IRIS	Neurological	0.0003	0.02%
p-Dichlorobenzene	106-46-7	0.2	800	IRIS	Liver	0.0003	0.02%

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Carbon Disulfide	75-15-0	0.142	700	IRIS	Neurological	0.0002	0.01%
Methyl Isobutyl Ketone	108-10-1	0.176	3000	IRIS	Developmental	0.0001	0.004%
Selenium	7782-49-2	0.00112	20	CAL	Skin/Neurological/Liver/Hematologic	0.0001	0.004%
1,2-Dichloroethane	107-06-2	0.0953	2400	ATSDR	Liver	0.00004	0.003%
					Hazard Index	**2**	

[1]Were assigned the RfC value of mixed Xylenes

Table 5.1.2-4 Non-cancer Hazard Quotients for the Shuttlesworth Station Chemicals of Potential Concern

Chemical	CAS #	95UCL Conc. (µg/m^3)	RfC (µg/m^3)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
Manganese	7439-96-5	0.02590	0.05	IRIS	Neurological	0.5	36%
Naphthalene	91-20-3	0.82500	3	IRIS	Respiratory	0.3	19%
Arsenic	7440-38-2	0.00270	0.015	CAL	Developmental	0.2	13%
Benzene	71-43-2	5.12500	30	IRIS	Immunological	0.2	12%
1,3-Butadiene	106-99-0	0.17400	2	IRIS	Reproductive	0.1	6%
Cadmium	7440-43-9	0.00067	0.01	D-ATSDR	Kidney/Respiratory	0.1	5%
Nickel	7440-02-0	0.00344	0.09	ATSDR	Respiratory	0.04	3%
m,p-Xylene[1]	108-38-3, 106-42-3	1.70900	100	IRIS	Neurological	0.02	1%
Chloromethane	74-87-3	1.24700	90	IRIS	Neurological	0.01	1%
Bromomethane	74-83-9	0.06190	5	IRIS	Respiratory	0.01	1%
Carbon Tetrachloride	56-23-5	0.73600	100	IRIS	Liver	0.007	0.5%
o-Xylene[1]	95-47-6	0.70400	100	IRIS	Neurological	0.007	0.5%
Tetrachloroethylene	127-18-4	0.24600	40	IRIS	Neurological	0.01	0.4%
Acetonitrile	75-05-8	0.28900	60	IRIS	Death	0.005	0.3%
Dichloromethane	75-09-2	2.68900	600	IRIS	Liver	0.004	0.3%
Cobalt	7440-48-4	0.00024	0.1	ATSDR	Respiratory	0.002	0.2%
Chloroform	67-66-3	0.19800	98	ATSDR	Liver	0.002	0.1%
Beryllium	7440-41-7	0.00003	0.02	IRIS	Respiratory	0.002	0.1%
Hexavalent Chromium	18540-29-9	0.00013	0.1	IRIS	Anemia/damage to Gastrointerstinal	0.001	0.09%
Styrene	100-42-5	0.99900	1000	IRIS	Neurological	0.001	0.1%
Toluene	108-88-3	3.41100	5000	IRIS	Neurological/Respiratory	0.0007	0.05%
Ethylbenzene	100-41-4	0.58300	1000	IRIS	Developmental	0.0006	0.04%
Propylene	115-07-1	1.14700	3000	CAL	Neurological	0.0004	0.03%
p-Dichlorobenzene	106-46-7	0.27800	800	IRIS	Liver	0.0003	0.02%
Mercury	7439-97-6	0.00004	0.3	IRIS	Neurological	0.0001	0.01%
Carbon Disulfide	75-15-0	0.08870	700	IRIS	Neurological	0.0001	0.01%
Methyl Isobutyl Ketone	108-10-1	0.20500	3000	IRIS	Developmental	0.00007	0.005%

Chemical	CAS #	95UCL Conc. ($\mu g/m^3$)	RfC ($\mu g/m^3$)	Source	Target Organ	95UCL Hazard Quotient	% Hazard
1,2-Dichloroethane	107-06-2	0.15800	2400	ATSDR	Liver	0.00007	0.005%
Selenium	7782-49-2	0.00096	20	CAL	Skin/Neurological/Liver/Hematologic	0.00005	0.003%
					Hazard Index	**1**	

[1]Were assigned the RfC value of mixed Xylene

Table 5.2-1 Comparison of Maximum Chemical Concentrations to Acute Benchmark Screening Limits for the 4 Monitoring Site[1]

Chemical		Maximum Concentration (µg/m^3)				EPA OAQPS Acute Toxicity Values (µg/m^3)										
Name	CAS #	HEAL	LEAL	RSAL	SLOSS	AEGL-1 (1-h)	AEGL-1 (8-h)	AEGL-2 (1-h)	AEGL-2 (8-h)	ERPG-1	ERPG-2	MRL	REL	IDLH/10	TEEL-0	TEEL-1
1,1,1-Trichloroethane	71-55-6	0.22371	0.130949	0.148682	0.300092372	1300000	130000	3300000	1700000	190000	3800000	11000	68000	380000		
1,1,2,2-Tetrachloroethane	79-34-5	0.71396												69000		
1,1,2-Trichloroethane	79-00-5	0.22916												55000		
1,1-Dichloroethane	75-34-3	0.1538		0.044522										1200000		
1,1-Dichloroethene	75-35-4	0.13084	0.043615		0.055509742										20000	79000
1,2,4-Trichlorobenzene	120-82-1	0.97218		1.165131											37000	37000
1,2-Dibromoethane	106-93-4	0.38418				130000	35000	180000	50000					77000		
1,2-Dichloroethane	107-06-2	0.22666	0.149755	0.136601	0.862102037					200000	810000			20000		
1,2-Dichloropropane	78-87-5	0.19409										230		180000		
1,3-Butadiene	106-99-0	0.64158	0.606178	0.919775	0.493348965	1500000	150000	12000000	6000000	22000	440000	220		440000		
Acetonitrile	75-05-8	3.5931	1.445649	9.041602	0.60613155	22000	22000	540000	140000					84000		
Acrylonitrile	107-13-1	0.2561	0.312521	0.881135	1.362937227	10000	10000	130000	19000	22000	77000	220		19000		
Arsenic	7440-38-2	0.0040	0.004650	0.010750	0.00745								0.2	500		
Benzene	71-43-2	21.885	20.446861	55.110681	22.71518503	170000	29000	2600000	640000	160000	480000	29	1300	160000		
Benzo (a) anthracene	56-55-3	0.0161	0.030100	0.038525	0.0137										100	300
Benzo (a) pyrene	50-32-8	0.00956	0.015300	0.021475	0.00753										200	600
Benzo (b) fluoranthene	205-99-2	0.0193	0.031900	0.047100	0.0153										200	600
Benzo (k) fluoranthene	207-08-9	0.00545	0.010600	0.013225	0.00438										200	600
Beryllium	7440-41-7	0.00008	0.000080	0.000078	0.00009						25			400		
Bromoform	75-25-2	0.8579												880000		
Bromomethane	74-83-9	0.1476	0.100957	0.446542	0.100957309			820000	260000		190000	190	3900	97000		
Cadmium	7440-43-9	0.00779	0.006680	0.002740	0.00246							0.03		900		

Chemical		Maximum Concentration (µg/m^3)				EPA OAQPS Acute Toxicity Values (µg/m^3)										
Carbon Disulfide	75-15-0	0.27092	0.199300	0.468667	0.183730102	40000	21000	500000	160000	3100	500000		6200	160000		
Carbon Tetrachloride	56-23-5	0.89966	0.987739	0.965719	0.937408057	280000	120000	1200000	510000	130000	630000		1900	130000		
Chlorobenzene	108-90-7	0.29924		11.393959		46000	46000	690000	690000					460000		
Chloroethane	75-00-3	0.108184	0.197897	0.357534	0.039579448							40000		1000000		
Chloroform	67-66-3	0.288069	0.302717	0.253892	0.80561773			310000	140000		240000	490	150	240000		
Chloromethane	74-87-3	1.761391	1.866703	20.639041	1.759325988			1900000	780000		830000	1000		410000		
Chloroprene	126-99-8	0.144845			0.264342106									110000		
Chromium	7440-47-3	0.017800	0.026100	0.016600	0.0304										1000	1500
Chrysene	218-01-9	0.016600	0.031500	0.046200	0.0163										200	600
Cobalt	7440-48-4	0.001220	0.000560	0.000673	0.00059		0.00026	0.00017	0.00030					2000		
Dibenz (a,h) anthracene	53-70-3	0.002250	0.003490	0.004693	0.00176										10000	30000
Dichloromethane	75-09-2	4.828490	3.341732	5.476342	23.1698	690000		1900000	210000	1000000	2600000	2100	14000	800000		
Ethylbenzene	100-41-4	1.810701	4.472475	3.601862	1.84543865	140000	140000	4800000	2500000			22000		350000		
Hexachloro-1,3-Butadiene	87-68-3	1.162497	0.437270							11000	32000					
Hexavalent Chromium	18540-29-9	0.00018	0.00026	0.00017	0.00030									1500		
Indeno(1,2,3-cd)pyrene	193-39-5	0.007120	0.009870	0.015725	0.00498										150	500
Lead	7439-92-1	1.130000	0.835000	0.067300	0.0432									10000		
m,x-Xylene	108-38-3, 106-42-3					560000	560000	4000000	1700000			8700	22000	390000		
Manganese	7439-96-5	0.117000	0.165000	0.057600	0.0607									50000		
Mercury	7439-97-6	0.000280	0.000090	0.000525	0.00014			1700	330		2000		0.6			
Methyl Isobutyl Ketone	108-10-1	0.516163	0.983168	0.430136	0.68002										310000	310000
Methyl Methacrylate	80-62-6	0.282539		3.044458		70000	70000	490000	200000					410000		
Methyl tert-Butyl Ether	1634-04-4	0.111764		0.068500	0.054079264	180000	180000	2100000	1400000			7200				
Naphthalene	91-20-3	2.020000	1.830000	5.735000	2.06									130000		
Nickel	7440-02-0	0.012600	0.010400	0.012100	0.0122								6	1000		

Chemical		**Maximum Concentration (µg/m^3)**				**EPA OAQPS Acute Toxicity Values (µg/m^3)**										
o-Xylene	95-47-6	2.8480	7.51200	4.4510	3.01300	560000	560000	4000000	1700000			8700	22000	390000		
p-Dichlorobenzene	106-46-7	0.943949	0.625291	1.274632	0.793639067							12000		90000		
Propylene	115-07-1															
Selenium	7782-49-2	0.002230	0.002240	0.003040	0.00236									100		
Styrene	100-42-5	4.430153	3.024432	3.714513	4.302360409	85000	85000	550000	550000	210000	1100000		21000	300000		
Tetrachloroethylene	127-18-4	0.834257	0.800344	2.723205	0.739300859	240000	240000	1600000	550000	680000	1400000	1400	20000	100000		
Toluene	108-88-3	27.434792	105.141578	31.806269	15.52628319	750000	750000	4500000	2400000	190000	1100000	3800	37000	190000		
Trichloroethylene	79-01-6	0.247194	0.279437	0.532004	0.225698724	700000	410000	2400000	1300000	540000	2700000	11000				
Vinyl chloride	75-01-4	0.076686	0.040899	0.080520	0.035786577	640000	180000	3100000	2100000	1300000	13000000	1300	180000			

[1]For all chemicals that were detected at or above respective detection limits at least once.